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(54) **DATA-CAPABLE NETWORK PRIORITIZATION WITH REJECT CODE HANDLING**

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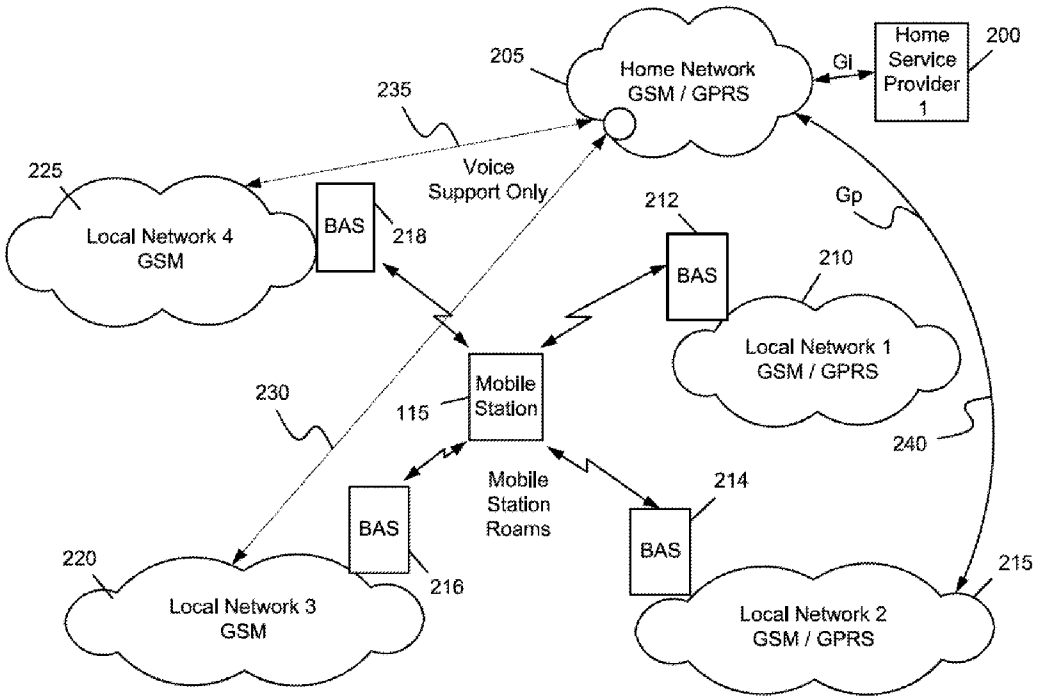
(52) **U.S. Cl.** ..... **455/435.2**

(57) **ABSTRACT**

Reject code handling is utilized for a more time-efficient selection of data-capable networks. One illustrative method for use in selecting a wireless communication network for communications involves the steps of selecting a first wireless network available for communications with the mobile station; causing a request for data connectivity to be transmitted to the first wireless network selected; if a rejection is received from the first wireless network in response to the request for data connectivity: reattempting the request for data connectivity to the first wireless network at least one time; selecting a second wireless network available for communications with the mobile station after the request for data connectivity to the first wireless network is reattempted the at least one time without success; and selecting the second wireless network available for communications with the mobile station without reattempting the request for data connectivity to the first wireless network the at least one time if a reject code associated with the rejection indicates that data services are not allowed in the first network is received from the first wireless network in response to the request for data connectivity.



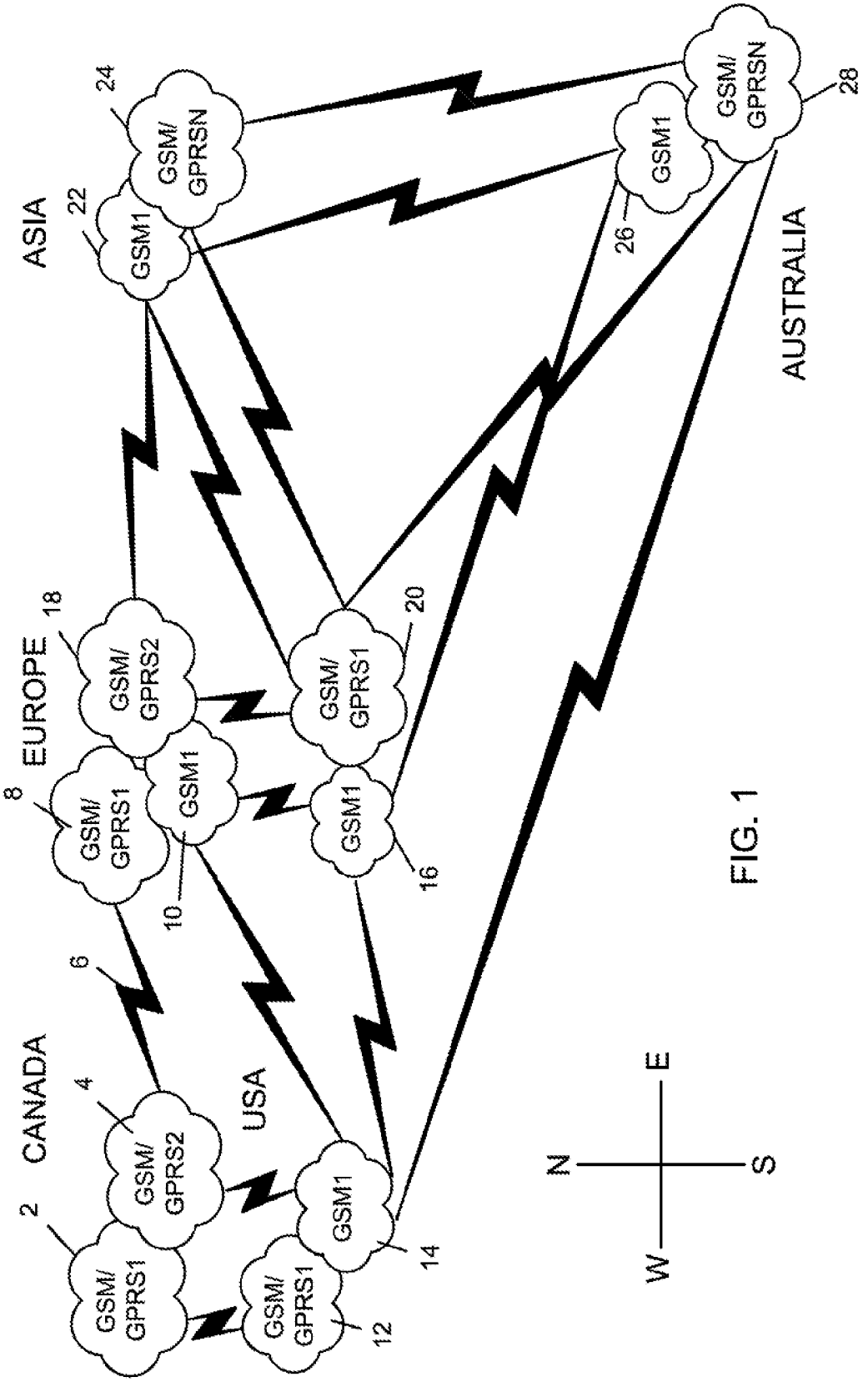

ASIA
22
24
GSM1
GSM/ GPRSN
EUROPE
8
18
20
GSM/ GPRS1
GSM1
GSM/ GPRS2
GSM/ GPRS1
10
16
CANADA
2
4
6
GSM/ GPRS1
GSM/ GPRS2
USA
12
14
GSM/ GPRS1
GSM1
AUSTRALIA
26
28
GSM1
GSM/ GPRSN
N
E
S
W

FIG. 1

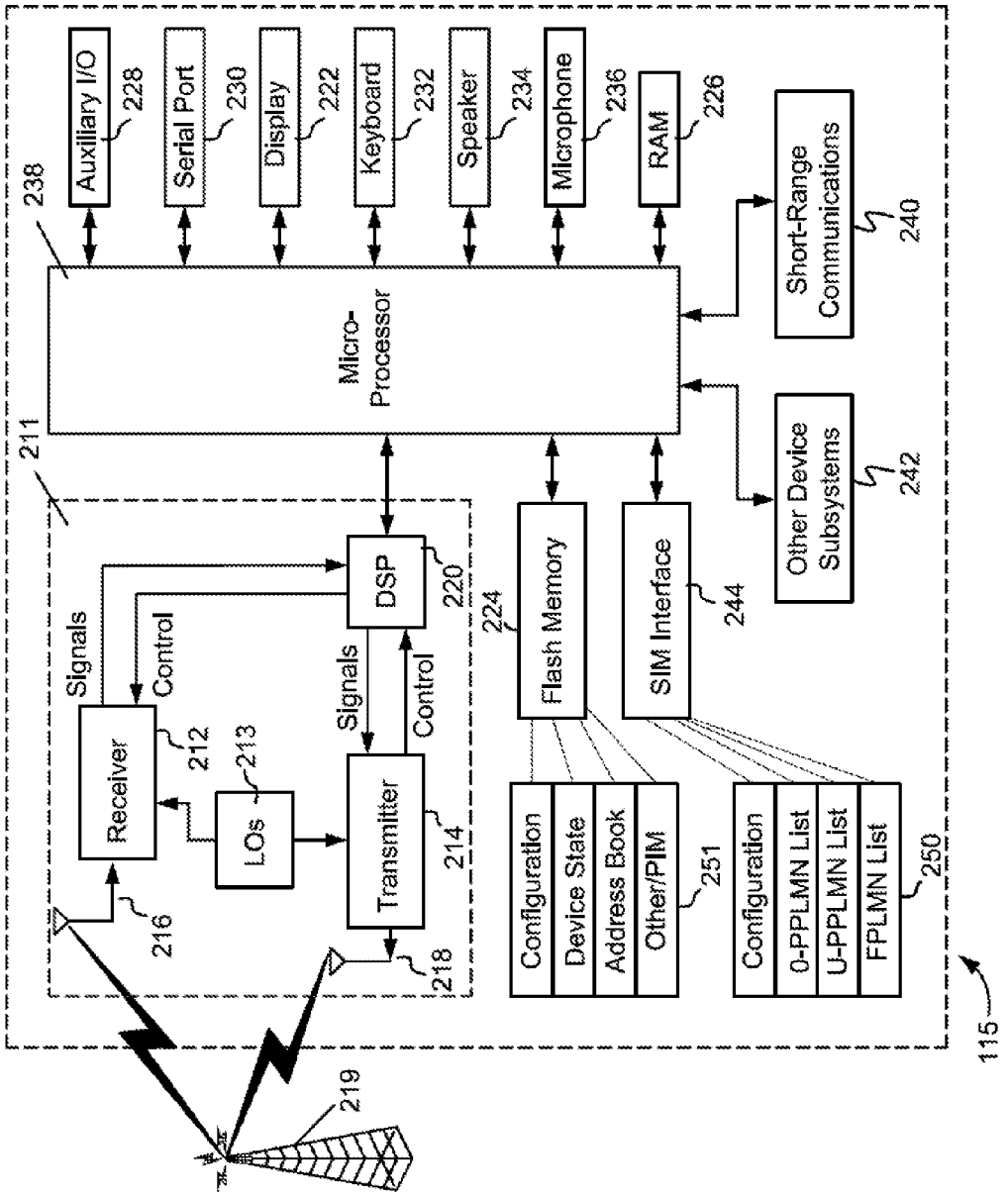
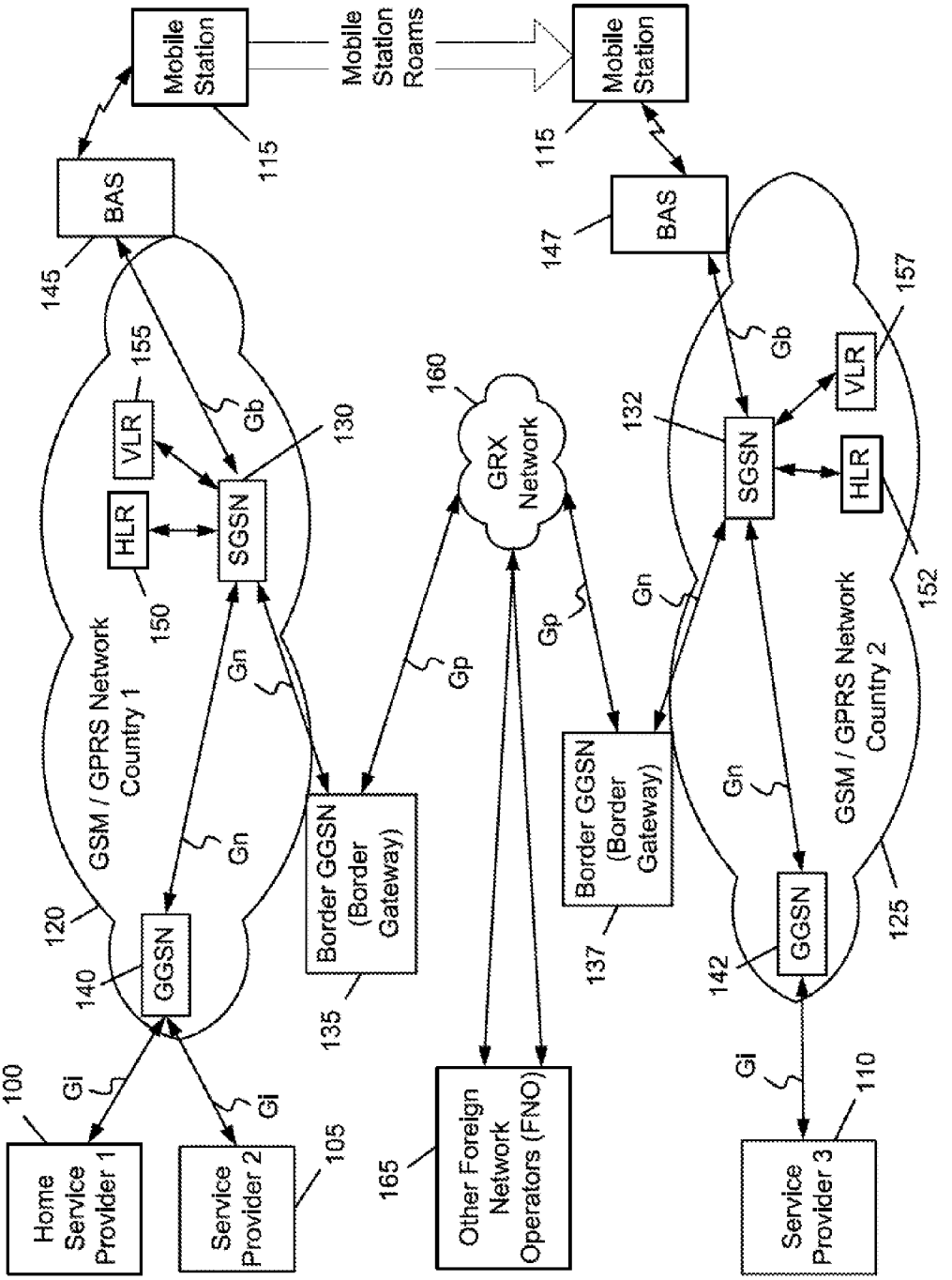

Auxiliary I/O
228
Serial Port
230
Display
222
Keyboard
232
Speaker
234
Microphone
236
RAM
226
238
Micro-Processor
Short-Range Communications
240
Other Device Subsystems
242
211
DSP
220
Signals
Control
Receiver
212
LOs
213
Signals
Control
Transmitter
214
216
218
219
224
Flash Memory
SIM Interface
244
Configuration
Device State
Address Book
Other/PIM
251
Configuration
0-PPLMN List
U-PPLMN List
FPLMN List
250
115

FIG. 2

FIG. 3


Mobile Station
Mobile Station Roams
Mobile Station
115
115
BAS
145
BAS
147
Gb
155
VLR
HLR
150
SGSN
130
160
GRX Network
132
SGSN
VLR
157
HLR
152
GSM / GPRS Network Country 1
120
GGSN
140
Gn
Gn
Gp
Gp
Gn
Border GGSN (Border Gateway)
135
Border GGSN (Border Gateway)
137
GSM / GPRS Network Country 2
125
GGSN
142
100
Gi
Gi
Gi
Home Service Provider 1
Service Provider 2
105
Other Foreign Network Operators (FNO)
165
Service Provider 3
110

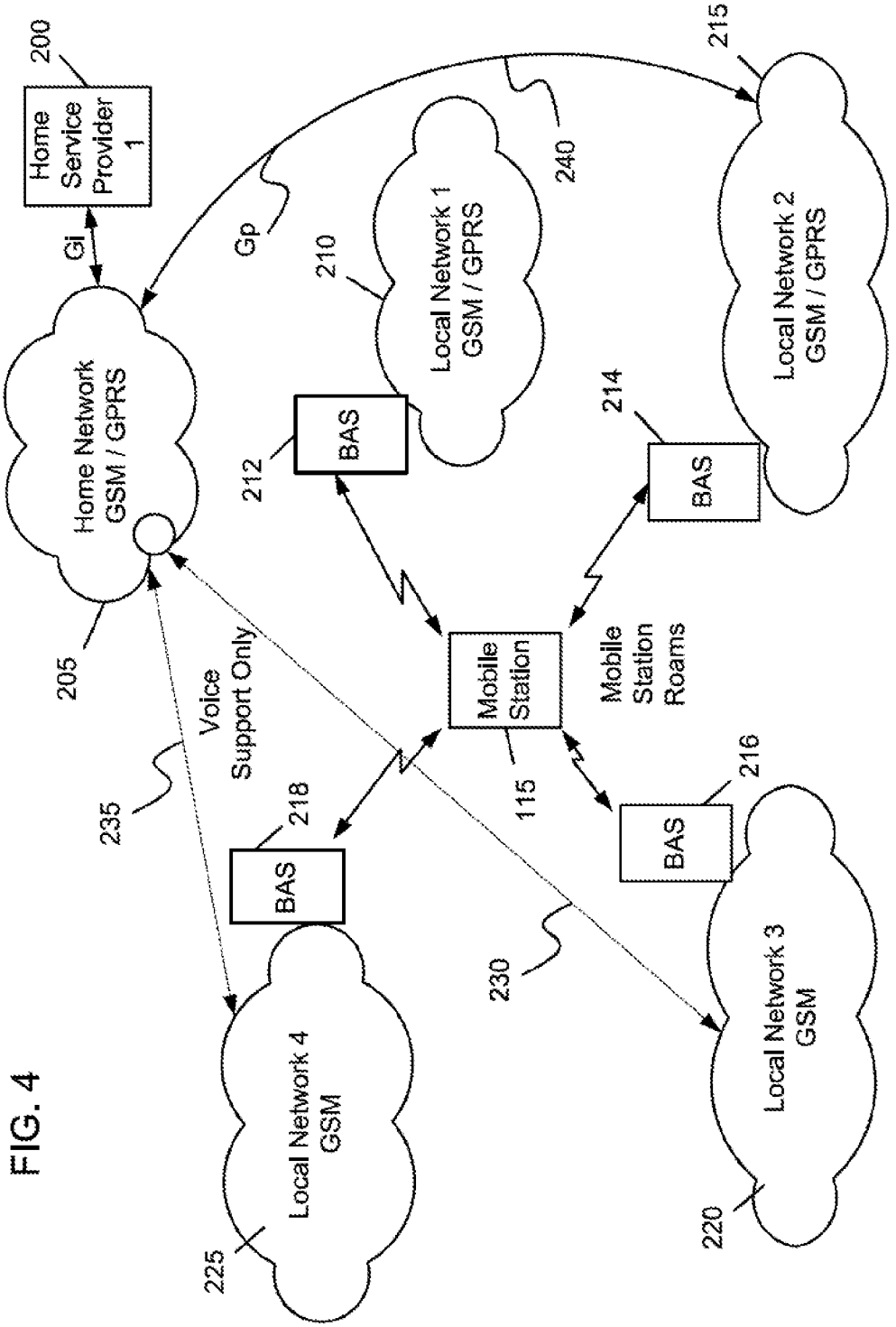

Home Service Provider 1
200
Gi
Gp
240
215
Local Network 2 GSM / GPRS
Local Network 1 GSM / GPRS
210
Home Network GSM / GPRS
205
212
BAS
214
BAS
Mobile Station
115
Mobile Station Roams
Voice Support Only
235
218
BAS
216
BAS
230
Local Network 4 GSM
225
Local Network 3 GSM
220

FIG. 4

FIG. 5

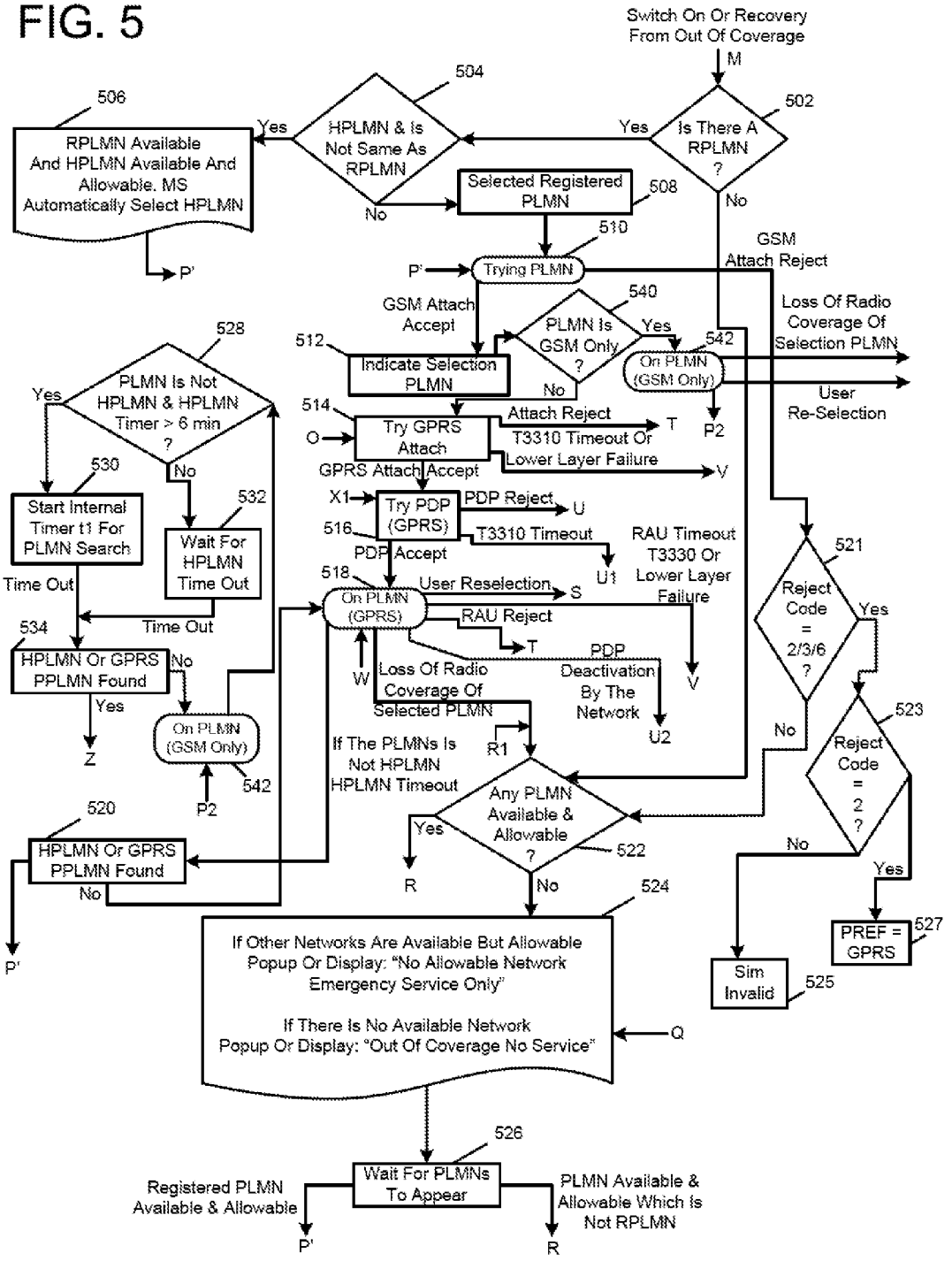

Switch On Or Recovery From Out Of Coverage
M
502
Is There A RPLMN ?
Yes
No
504
HPLMN & Is Not Same As RPLMN
Yes
No
506
RPLMN Available And HPLMN Available And Allowable. MS Automatically Select HPLMN
P'
Selected Registered PLMN
508
510
Trying PLMN
P'
GSM Attach Reject
GSM Attach Accept
540
PLMN Is GSM Only ?
Yes
No
542
On PLMN (GSM Only)
Loss Of Radio Coverage Of Selection PLMN
User Re-Selection
P2
512
Indicate Selection PLMN
514
Try GPRS Attach
O
Attach Reject
T3310 Timeout Or Lower Layer Failure
T
V
GPRS Attach Accept
528
PLMN Is Not HPLMN & HPLMN Timer > 6 min ?
Yes
No
530
Start Internal Timer t1 For PLMN Search
Time Out
532
Wait For HPLMN Time Out
Time Out
X1
Try PDP (GPRS)
PDP Reject
U
516
T3310 Timeout
U1
PDP Accept
RAU Timeout T3330 Or Lower Layer Failure
518
On PLMN (GPRS)
User Reselection
S
RAU Reject
T
PDP Deactivation By The Network
V
U2
W
Loss Of Radio Coverage Of Selected PLMN
534
HPLMN Or GPRS PPLMN Found
No
Yes
Z
On PLMN (GSM Only)
542
P2
If The PLMNs Is Not HPLMN HPLMN Timeout
R1
Any PLMN Available & Allowable ?
Yes
No
522
R
520
HPLMN Or GPRS PPLMN Found
No
P'
524
If Other Networks Are Available But Allowable Popup Or Display: "No Allowable Network Emergency Service Only"
If There Is No Available Network Popup Or Display: "Out Of Coverage No Service"
Q
521
Reject Code = 2/3/6 ?
Yes
No
523
Reject Code = 2 ?
No
Yes
Sim Invalid
525
PREF = GPRS
527
526
Wait For PLMNs To Appear
Registered PLMN Available & Allowable
P'
PLMN Available & Allowable Which Is Not RPLMN
R

FIG. 6

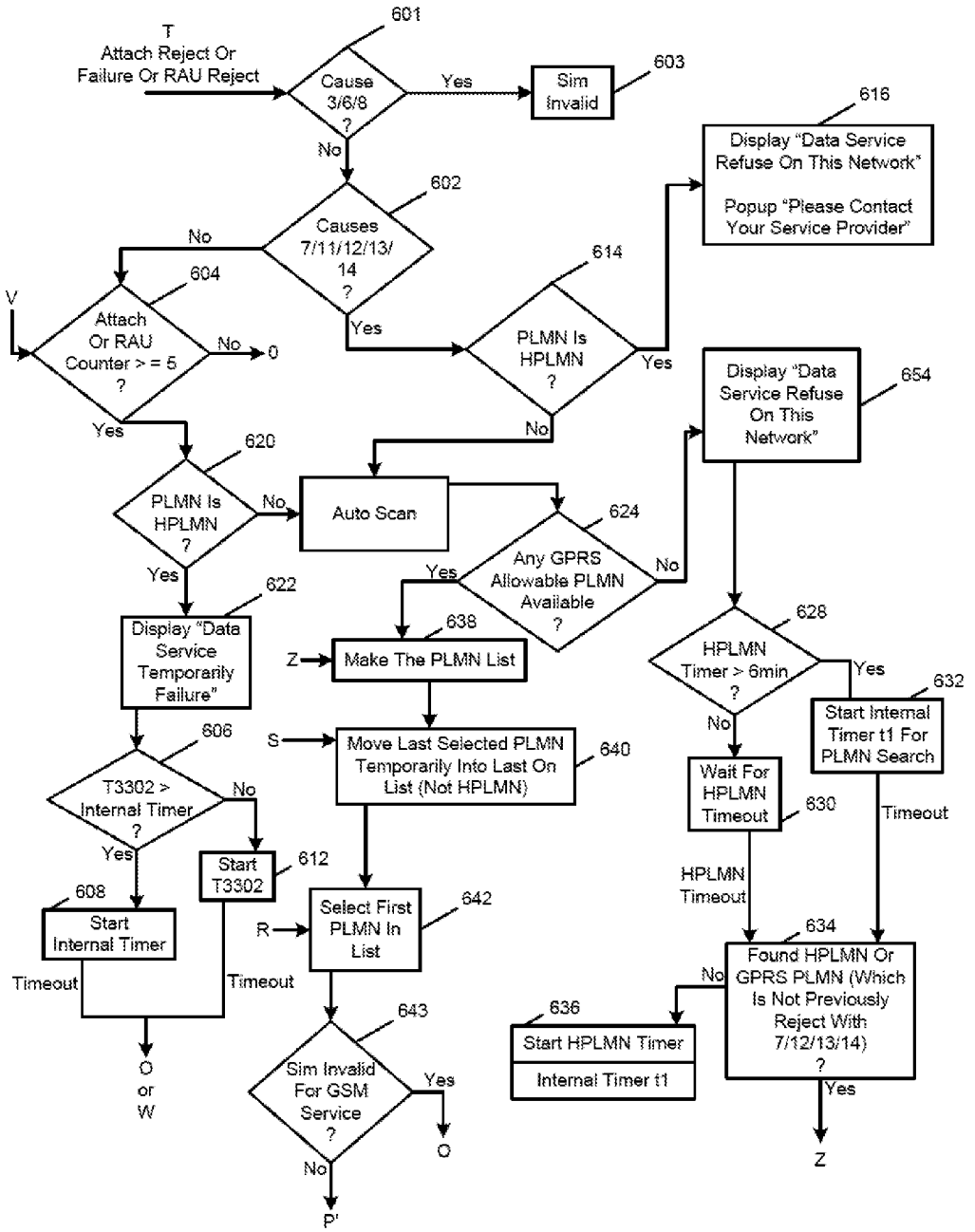

T
Attach Reject Or Failure Or RAU Reject
601
Cause 3/6/8 ?
Yes
Sim invalid
603
No
602
Causes 7/11/12/13/14 ?
No
Yes
604
Attach Or RAU Counter > = 5 ?
No
0
Yes
V
614
PLMN Is HPLMN ?
Yes
No
616
Display "Data Service Refuse On This Network"
Popup "Please Contact Your Service Provider"
620
PLMN Is HPLMN ?
No
Yes
Auto Scan
624
Any GPRS Allowable PLMN Available ?
Yes
No
654
Display "Data Service Refuse On This Network"
622
Display "Data Service Temporarily Failure"
638
Z
Make The PLMN List
628
HPLMN Timer > 6min ?
Yes
No
632
Start Internal Timer t1 For PLMN Search
606
T3302 > Internal Timer ?
No
Yes
S
Move Last Selected PLMN Temporarily Into Last On List (Not HPLMN)
640
Wait For HPLMN Timeout
630
Timeout
HPLMN Timeout
608
Start Internal Timer
612
Start T3302
R
Select First PLMN In List
642
Timeout
Timeout
643
Sim Invalid For GSM Service ?
Yes
No
O
O or W
P'
634
Found HPLMN Or GPRS PLMN (Which Is Not Previously Reject With 7/12/13/14) ?
No
Yes
636
Start HPLMN Timer
Internal Timer t1
Z

FIG. 7

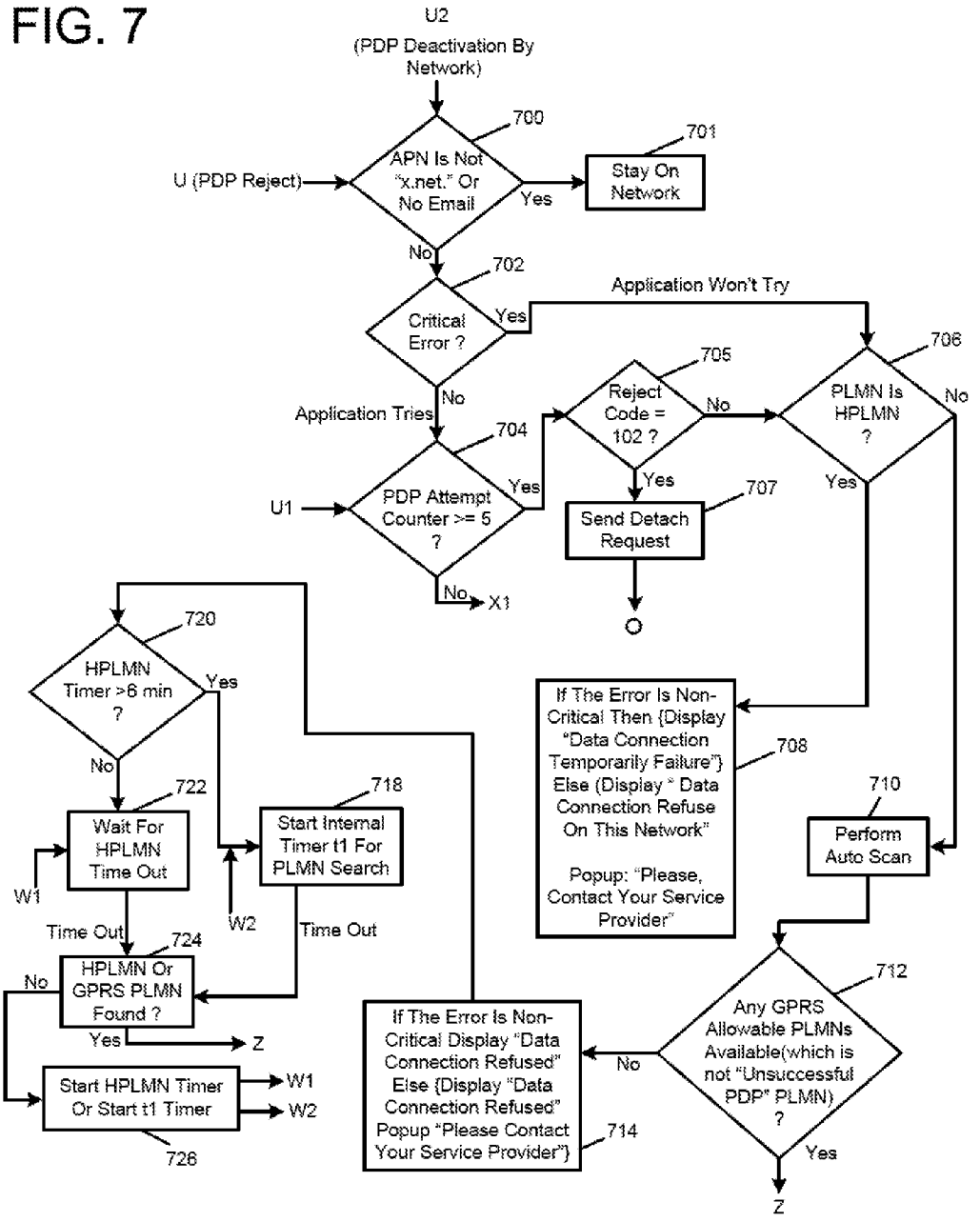

U2
(PDP Deactivation By Network)
700
APN Is Not "x.net." Or No Email
U (PDP Reject)
Yes
701
Stay On Network
No
702
Critical Error ?
Yes
Application Won't Try
No
Application Tries
704
PDP Attempt Counter >= 5 ?
U1
Yes
No
X1
705
Reject Code = 102 ?
No
Yes
707
Send Detach Request
O
706
PLMN Is HPLMN ?
No
Yes
If The Error Is Non-Critical Then {Display "Data Connection Temporarily Failure"} Else {Display " Data Connection Refuse On This Network"
Popup: "Please, Contact Your Service Provider"
708
710
Perform Auto Scan
712
Any GPRS Allowable PLMNs Available(which is not "Unsuccessful PDP" PLMN) ?
No
Yes
Z
If The Error Is Non-Critical Display "Data Connection Refused" Else {Display "Data Connection Refused" Popup "Please Contact Your Service Provider"}
714
720
HPLMN Timer >6 min ?
Yes
No
722
Wait For HPLMN Time Out
W1
Time Out
724
HPLMN Or GPRS PLMN Found ?
No
Yes
Z
Start HPLMN Timer Or Start t1 Timer
W1
W2
726
718
Start Internal Timer t1 For PLMN Search
W2
Time Out

FIG. 8

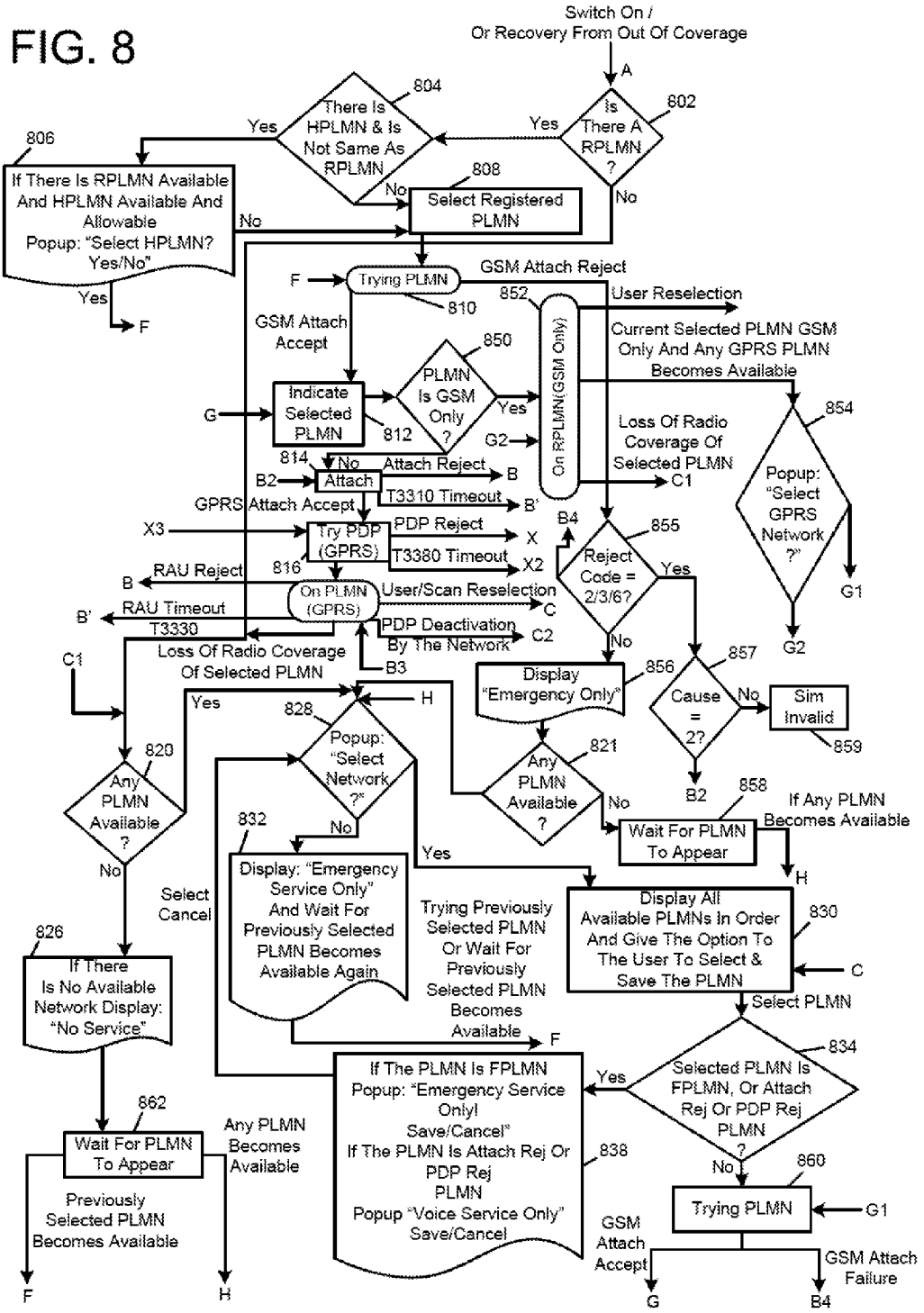
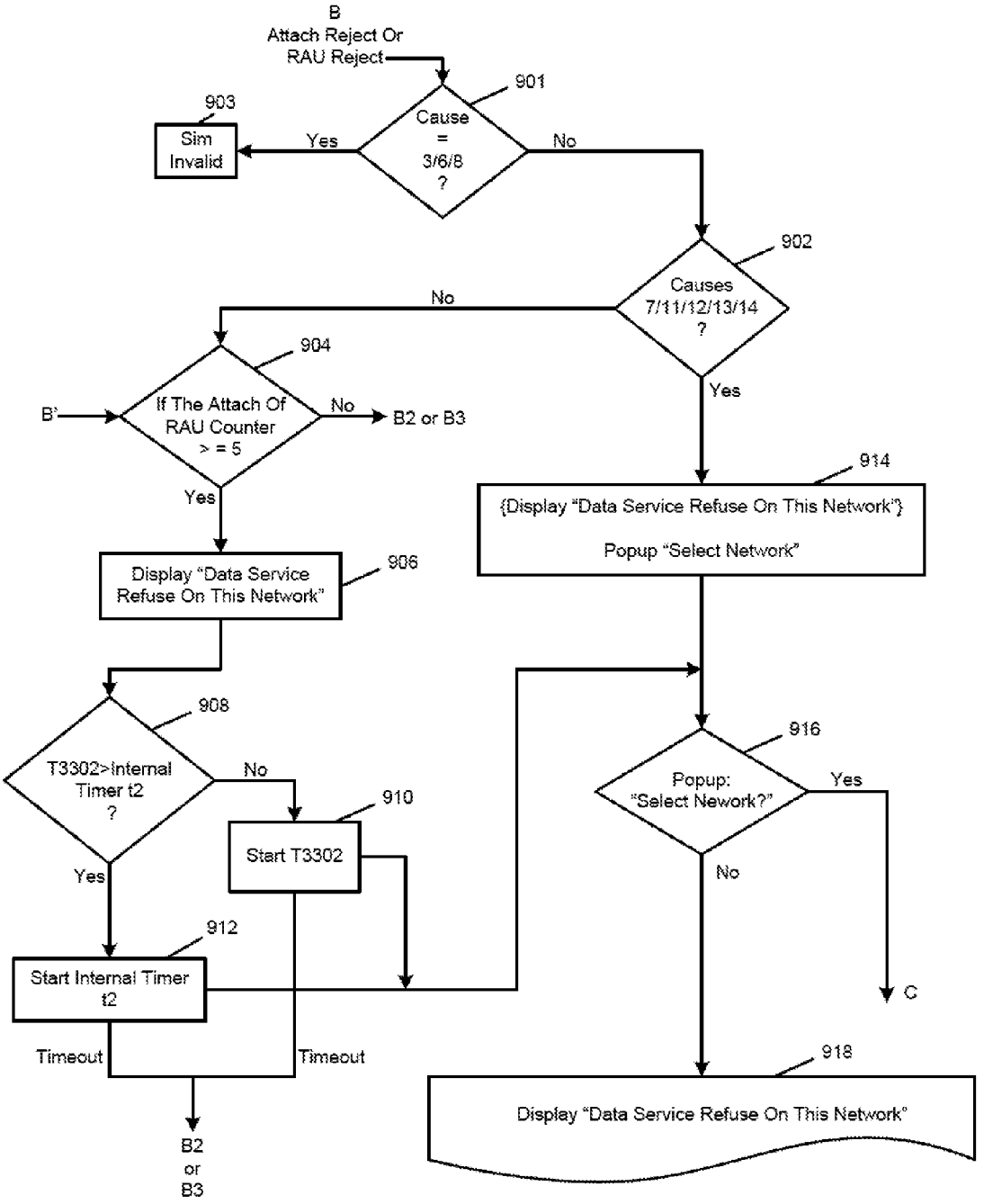

Switch On / Or Recovery From Out Of Coverage
A
802
Is There A RPLMN ?
804
There Is HPLMN & Is Not Same As RPLMN
806
If There Is RPLMN Available And HPLMN Available And Allowable Popup: "Select HPLMN? Yes/No"
808
Select Registered PLMN
Yes
No
F
Trying PLMN
810
GSM Attach Reject
852
User Reselection
GSM Attach Accept
850
PLMN Is GSM Only ?
On RPLMN(GSM Only)
Current Selected PLMN GSM Only And Any GPRS PLMN Becomes Available
G
Indicate Selected PLMN
812
G2
Loss Of Radio Coverage Of Selected PLMN
C1
854
Popup: "Select GPRS Network ?"
G1
G2
814
Attach
Attach Reject
B
B2
T3310 Timeout
B'
GPRS Attach Accept
X3
Try PDP (GPRS)
PDP Reject
X
T3380 Timeout
X2
816
On PLMN (GPRS)
RAU Reject
User/Scan Reselection
C
RAU Timeout
T3330
PDP Deactivation By The Network
C2
Loss Of Radio Coverage Of Selected PLMN
B3
B4
855
Reject Code = 2/3/6?
Yes
No
Display "Emergency Only"
856
857
Cause = 2?
No
Sim Invalid
859
B2
858
If Any PLMN Becomes Available
Wait For PLMN To Appear
H
821
Any PLMN Available ?
No
Yes
828
Popup: "Select Network ?"
H
820
Any PLMN Available ?
No
Yes
832
Display: "Emergency Service Only" And Wait For Previously Selected PLMN Becomes Available Again
Select Cancel
Trying Previously Selected PLMN Or Wait For Previously Selected PLMN Becomes Available
F
Display All Available PLMNs In Order And Give The Option To The User To Select & Save The PLMN
830
C
Select PLMN
826
If There Is No Available Network Display: "No Service"
834
Selected PLMN Is FPLMN, Or Attach Rej Or PDP Rej PLMN ?
Yes
No
If The PLMN Is FPLMN Popup: "Emergency Service Only! Save/Cancel" If The PLMN Is Attach Rej Or PDP Rej PLMN Popup "Voice Service Only" Save/Cancel
838
860
Trying PLMN
G1
862
Wait For PLMN To Appear
Any PLMN Becomes Available
Previously Selected PLMN Becomes Available
F
H
GSM Attach Accept
G
GSM Attach Failure
B4

FIG. 9


B
Attach Reject Or
RAU Reject
901
Cause
=
3/6/8
?
Yes
No
903
Sim
Invalid
902
Causes
7/11/12/13/14
?
No
Yes
904
If The Attach Of
RAU Counter
> = 5
B'
No
B2 or B3
Yes
914
{Display "Data Service Refuse On This Network"}
Popup "Select Network"
Display "Data Service
Refuse On This Network"
906
908
T3302>Internal
Timer t2
?
No
Yes
910
Start T3302
916
Popup:
"Select Nework?"
Yes
No
C
912
Start Internal Timer
t2
Timeout
Timeout
B2
or
B3
918
Display "Data Service Refuse On This Network"

# DATA-CAPABLE NETWORK PRIORITIZATION WITH REJECT CODE HANDLING

## CROSS-REFERENCE TO RELATED APPLICATIONS

**[0001]** The present application is a continuation of and claims priority to U.S. non-provisional patent application having application Ser. No. 11/674,738 and filing date of 14 Feb. 2007, now U.S. Pat. No. _____, which is a continuation of U.S. non-provisional patent application having application Ser. No. 10/987,658 and filing date of 12 Nov. 2004, now U.S. Pat. No. 7,197,312 B2 (which is subject to reissue application having application Ser. No. 12/412,963 and having filing date of 27 Mar. 2009), which claims priority to U.S. provisional patent application having application No. 60/519,150 and filing date of 12 Nov. 2003 and U.S. provisional patent application having application No. 60/519,141 and filing date of 12 Nov. 2003, each application being hereby incorporated by reference herein.

## BACKGROUND

**[0002]** 1. Field of the Technology

**[0003]** The present application relates generally to mobile stations and network selection methods employed thereby.

**[0004]** 2. Description of the Related Art

**[0005]** A mobile communication device, such as a cellular mobile station, may be capable of making and receiving telephone calls and/or sending and receiving data over a wireless communication network. Before it is able to do this, the mobile station selects and registers with one of a plurality of communication networks which are available within its geographic coverage area. After registering with the selected network, the mobile station operates in an idle mode where it "camps-on" a particular wireless communication channel of the network to monitor for calls or messages. "Network selection" is the particular process performed by the mobile station for selecting the one communication network through which to register and operate.

**[0006]** Cellular telephony operation and network selection schemes are documented in standards specifications that govern the behavior of cellular mobile stations and associated systems. One well-known cellular standard is the Global System for Mobile Communications (GSM) standard. GSM 03.22/European Technical Standards Institute (ETSI) Technical Specification (TS) 100 930, Technical Specification (TS) 23.122 from the 3rd Generation Partnership Project (3GPP), and other related standards documents describe the many details of cellular operation and network selection. These documents describe how a mobile station behaves as it moves and roams between various regions and countries to maintain coverage with networks (referred to as Public Land Mobile Networks or PLMNs), primarily for the purpose of providing continuous telephone service.

**[0007]** Traditionally, a mobile station performs network selection by initially scanning to identify all available communication networks within its surrounding coverage area. Each network is identified by a unique Mobile Country Code (MCC) and Mobile Network Code (MNC) pair. If the Home Public Land Mobile Network (HPLMN) or "home network" of the mobile station is available, the mobile station will ordinarily select and operate with the home network. If the HPLMN is unavailable, the mobile station will ordinarily select and operate with the communication network having the highest priority in a preferred network list stored in memory of the mobile station. There may be several preferred network lists, commonly referred to as Preferred PLMN lists (PPLMN lists), stored on a Subscriber Identity Module (SIM) card of the mobile station. For example, the PPLMN lists may include a user-controlled PPLMN (U-PPLMN) list and an operator-controlled PPLMN (O-PPLMN) list.

**[0008]** The above-described network selection method is commonly referred to as an "automatic" network selection method. As an alternative to this automatic selection method, an end-user of the mobile station may be provided with the ability to manually select from a plurality of listed available networks which are visibly displayed on the mobile device. This conventional network selection method may be referred to as a "manual" network selection method.

**[0009]** Mobile data communication devices which are known to facilitate services such as wireless e-mail, Internet access, as well as voice telephony, are becoming more and more popular. In addition to operating in accordance with GSM for voice telephony, these mobile stations may operate in accordance with General Packet Radio Service (GPRS). GPRS is a packet-based communication protocol for mobile stations that allows data packets to be sent and received through a wireless communication network. In order to receive data services through a GPRS-capable network, the mobile station first performs a "GPRS attach" and provides its identification code and availability to the wireless network. For GSM/GPRS, this code could include both the International Mobile Subscriber Identity (IMSI) or Packet Temporary Mobile Subscriber Identity (PTMSI), which identify a communication network account or subscription, and a Mobile Station ISDN/PSTN Number MSISDN, which identifies the mobile station user or subscriber. After attaching to the network, the mobile station will attempt to establish a "Packet Data Protocol (PDP) context". The PDP context targets an access point name (APN) and home service of the mobile station. The PDP context also allocates an IP address for the mobile station so that IP packets can be communicated.

**[0010]** In order to operate fully as intended, these "data-capable" mobile stations must have the appropriate communication services supported and made available by the communication network that it is registered with. Ideally, all communication networks around the world should be connected through roaming agreements, and support and make available all the different types of communication services that a mobile station is capable of providing. In practice, however, some communication networks do not have or cannot make a particular communication service (e.g. a data communication service) available to a mobile station. This problem may be partially mitigated in a given coverage area, as there may be several communication networks from which the mobile station may select.

**[0011]** Traditional network selection techniques for GSM services, however, do not take into consideration the availability of other services (e.g. data communication services) in its decision-making process. That is, traditional network selection techniques are voice-service-centric. As a result, an inadequate communication network may be selected by such mobile stations. For example, a mobile station may select a communication network that can provide an acceptable voice service but not a data service, even though another adequate and available network could provide both the voice and the

data service. Such traditional operation is undesirable, especially for mobile stations that are primarily intended to provide the end-user with a data communication service (e.g. portable e-mail devices). In particular, a GPRS/GSM-capable network is more preferably for these mobile stations than are GSM-only networks.

**[0012]** A better and non-traditional network selection technique for these mobile stations would involve prioritizing the selection of data-capable communication networks (e.g. GPRS) over voice-only networks (e.g. GSM). In such a procedure, the mobile station may have to determine whether or not the data service is actually made available by the communication network. More particularly, the mobile station makes a request for a data service which may be accepted or denied by the network. When data service is denied, the mobile station receives different "reject cause codes" from the network which are associated with different reasons for service denial. Depending on the reject code, the mobile station may have to wait until it may request the data service again, a timer expires, the network changes, or the user cycles the power (off & on) of the mobile device. If the end user is not viewing the display of the mobile station (e.g. the mobile station is carried in a holster), the user will not be aware of the data service unavailability and may not receive important push data in a timely fashion (e.g. pushed e-mail messages).

**[0013]** In a related problem, if the GPRS attach or a Routing Area Update (RAU) attempt is not successful with the network (e.g. no network response, or the receipt of a rejection code), the mobile station consecutively reattempts for up to five (5) times. If the GPRS attach or RAU attempt counter is greater than or equal to five, the mobile station must place itself into a "GPRS Deregistered" state and start a timer designated as "timer **3302**". Timer **3302** is set to a value taken from GSM timer **3212**, which is a periodic location update timer. See e.g. 3GPP specification 4.08 Release 1997. From 3GPP specification 24.08 Release 1999, the default value of T3302 is 12 minutes if one is not provided by the network. Thus, the mobile station ordinarily receives the value for timer **3212** over-the-air by the network or, if one is not provided by the network, utilizes a default value. If provided over-the-air by the network, the timer may be set to up to four (4) hours. The mobile station is not able to attempt for GPRS services again until this timer **3302** expires. As apparent, this may cause substantial data delays (e.g. delays in receiving "pushed" e-mail messages).

**[0014]** Accordingly, there is a resulting need for network selection methods and apparatus that overcome the deficiencies of the prior art.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0015]** FIG. **1** is a block diagram illustrating a global network interconnection;

**[0016]** FIG. **2** is a block diagram of a mobile communication device which is a cellular mobile station;

**[0017]** FIG. **3** is a block diagram showing two GSM/GPRS networks and a mobile station roaming between them;

**[0018]** FIG. **4** is a block diagram illustrating a mobile station in a region where there are several communication networks of different types;

**[0019]** FIGS. **5**, **6**, and **7** form a flowchart for automatic network selection according to the present application; and

**[0020]** FIGS. **8**, **9**, and **10** form a flowchart for manual network selection according to the present application.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0021]** Methods and apparatus for performing network selection by a mobile communication device are described herein. In situations where more than one wireless network is available in a given coverage area, a method of selecting or assigning priority to a wireless network that provides a data service (or the "best" services) over ones that do not is utilized. Such methods are applicable to mobile devices that operate in accordance with any suitable communication standard, but are particularly applicable to advanced General Packet Radio Service (GPRS) capable mobile stations. In this environment, the method may place a priority on selecting a GPRS-capable network over a Global System for Mobile Communications (GSM) only capable network.

**[0022]** In particular, reject code handling is utilized for a time-efficient selection of data-capable networks. One illustrative technique of the present application includes the steps of causing a request for data connectivity to be transmitted through a first wireless network; reattempting the request for data connectivity through the first wireless network one or more times if a reject code comprising a non-critical error is received in response to the request for data connectivity through the first wireless network; and attempting to select a second wireless network for communications without reattempting the request for data connectivity through the first wireless network one or more times if a reject code comprising a critical error is received in response to the request for data connectivity through the first wireless network. A critical error is deemed one in which a permanent problem or fault exists with the network or service subscription associated with the end user; a non-critical error is not critical but rather is one in which there is a problem or fault with the network or service subscription that may be passing or temporary. Conventionally, the time period between the first attempt for data connectivity through the first wireless network (including all reattempts) and the first attempt for data connectivity through the second wireless network may be between about 25 minutes and 4 hours. As apparent, the inventive techniques reduce this time period to provide for a more time-efficient selection of a data-capable network.

**[0023]** Further, an indication is made in memory of the mobile station of whether the wireless network currently makes voice and data connectivity available to the mobile station. The indication for the wireless network may be indicative of "currently available data connectivity" if the request for data connectivity is accepted by the wireless network, or indicative of "currently unavailable data connectivity" if the reject code comprising the critical error is received or if the one or more requests for data connectivity through the wireless network are reattempted without success. Similar results may be achieved through use of a list of currently unavailable data connectivity networks stored in memory. Such a list includes the wireless network if the reject code comprising the critical error is received or if the one or more requests for data connectivity through the wireless network are reattempted without success; however the list fails to include the wireless network if the request for data connectivity is accepted by it.

**[0024]** With reference now to FIG. **1**, an overview of how networks connect around the world are described. GSM and GPRS networks are shown as example wireless communication networks. The voice network known as GSM is the older

component and has been available since about 1992 while GPRS, a data component that has been combined or overlaid with GSM, has been available only since about 1999. These two networks are now common throughout the world and have some of the fastest deployment rates of any voice and data networks. Such combined voice and data networks also include modern Code Division Multiple Access (CDMA) networks and third-generation (3G) networks like Enhanced Data-rates for Global Evolution (EDGE) and Universal Mobile Telecommunications Systems (UMTS), currently under development.

**[0025]** In FIG. **1**, there are five GSM only networks **10**, **14**, **16**, **22**, **26** and eight GSM/GPRS combined networks **2**, **4**, **8**, **12**, **18**, **20**, **24**, **28**, shown in various parts of the world. At any point in time, a given country might have one or more GSM and/or GSM/GPRS networks. Each network operator makes financial and practical decisions as to when it should purchase and implement GPRS functionality onto an existing GSM network. Therefore, a user of a GSM phone or a GPRS capable mobile station might enter a given country and be faced with networks that support either GSM only or combined GSM/GPRS.

**[0026]** These networks implement interconnections to each other to support roaming between countries and to support billing and roaming notifications between networks. Although shown as separate physical networks in FIG. **1**, the thirteen networks (five GSM and eight GSM/GPRS) interconnect to form a total of four networks—three GSM/GPRS networks **1**, **2**, and N, and one GSM network **1**. A GSM network could connect to one or more other GSM networks, one or more GSM/GPRS networks, or both. A GSM/GPRS network could similarly connect with other GSM/GPRS networks, GSM networks, or both GPRS/GSM networks and GSM networks. Networks in Canada, shown as GSM/GPRS**1** **2** and GSM/GPRS**2** **4**, respectively connect with GSM/GPRS**1** **12** and GSM**1** **14** shown in the USA. GSM/GPRS**2** **4** also connects with GSM/GPRS**1** **8** shown in the England area via communication link **6**. Network GSM**1** **14** from the USA also connects with GSM**1** **10** shown in the middle of Europe. Other networks **16** through **28** are similarly interconnected as shown. These interconnections form the basis of traffic movement and roaming support between the networks.

**[0027]** As a mobile station enters a given country or communication network coverage area, it may be capable of communicating with one or more wireless GSM or GSM/GPRS networks to receive data and voice signals. In England, for example, there are currently four GSM or GSM/GPRS networks deployed and available for mobile stations to connect with. Normally, cellular telephones or mobile stations sold in England will only work with one network. However, mobile stations entering England from France might have two or three networks to select from. Selection of a particular network is currently performed by a mobile station randomly, based on the strongest received signal at the time of arrival into the country.

**[0028]** Turning now to FIG. **2**, a block diagram is shown of a cellular mobile station, which is one type of mobile communication device. Mobile station **115** is preferably a two-way wireless communication device having at least voice and data communication capabilities. Mobile station **115** preferably has the capability to communicate with other computer systems on the Internet. Depending on the exact functionality provided, the mobile device may be referred to as a data messaging device, a two-way pager, a wireless e-mail device, a cellular telephone with data messaging capabilities, a wireless Internet appliance, or a data communication device, as examples.

**[0029]** Where mobile station **115** is enabled for two-way communication, it will incorporate a communication subsystem **211**, including both a receiver **212** and a transmitter **214**, as well as associated components such as one or more, preferably embedded or internal, antenna elements **216** and **218**, local oscillators (LOs) **213**, and a processing module such as a digital signal processor (DSP) **220**. As will be apparent to those skilled in the field of communications, the particular design of the communication subsystem **211** will be dependent upon the communication network in which the device is intended to operate. For example, mobile station **115** may include a communication subsystem **211** designed to operate within the Mobitex™ mobile communication system, the DataTAC™ mobile communication system, or a GPRS network.

**[0030]** Network access requirements will also vary depending upon the type of network **219**. For example, in the Mobitex and DataTAC networks, mobile station **115** is registered on the network using a unique identification number associated with each mobile station. In GPRS networks, however, network access is associated with a subscriber or user of mobile station **115**. A GPRS mobile station therefore requires a subscriber identity module (SIM) card in order to operate on a GPRS network. Without a valid SIM card, a GPRS mobile station will not be fully functional. Local or non-network communication functions, as well as legally required functions (if any) such as "911" emergency calling, may be available, but mobile station **115** will be unable to carry out any other functions involving communications over the network **219**. The SIM interface **244** is normally similar to a card-slot into which a SIM card can be inserted and removed. The SIM card can have approximately 64K of memory and hold many key configuration, identification, and subscriber related information **250**. The O-PPLMN, the U-PPLMN, and the forbidden PLMN (FPLMN) are initially received from the SIM card **250**. Reference to the PPLMN hereinafter will generally apply to both the O-PPLMN and U-PPLMN.

**[0031]** When required network registration or activation procedures have been completed, mobile station **115** may send and receive communication signals over the network **219**. Signals received by antenna **216** through communication network **219** are input to receiver **212**, which may perform such common receiver functions as signal amplification, frequency down conversion, filtering, channel selection and the like, and in the example system shown in FIG. **2**, analog to digital (A/D) conversion. A/D conversion of a received signal allows more complex communication functions such as demodulation and decoding to be performed in the DSP **220**. In a similar manner, signals to be transmitted are processed, including modulation and encoding for example, by DSP **220** and input to transmitter **214** for digital to analog conversion, frequency up conversion, filtering, amplification and transmission over the communication network **219** via antenna **218**. DSP **220** not only processes communication signals, but also provides for receiver and transmitter control. For example, the gains applied to communication signals in receiver **212** and transmitter **214** may be adaptively controlled through automatic gain control algorithms implemented in DSP **220**.

**[0032]** Mobile station **115** preferably includes a microprocessor **238** which controls the overall operation of the device. Communication functions, including at least data and voice communications, are performed through communication

subsystem **211**. Microprocessor **238** also interacts with further device subsystems such as the display **222**, flash memory **224**, random access memory (RAM) **226**, auxiliary input/output (I/O) subsystems **228**, serial port **230**, keyboard **232**, speaker **234**, microphone **236**, a short-range communications subsystem **240** and any other device subsystems generally designated as **242**.

**[0033]** Some of the subsystems shown in FIG. **2** perform communication-related functions, whereas other subsystems may provide "resident" or on-device functions. Notably, some subsystems, such as keyboard **232** and display **222**, for example, may be used for both communication-related functions, such as entering a text message for transmission over a communication network, and device-resident functions such as a calculator or task list.

**[0034]** Operating system software used by the microprocessor **238** is preferably stored in a persistent store such as flash memory **224**, which may instead be a read-only memory (ROM) or similar storage element (not shown). Those skilled in the art will appreciate that the operating system, specific device applications, or parts thereof, may be temporarily loaded into a volatile memory such as RAM **226**. Received communication signals may also be stored in RAM **226**.

**[0035]** Microprocessor **238**, in addition to its operating system functions, preferably enables execution of software applications on the mobile station. A predetermined set of applications that control basic operations, including at least data and voice communication applications for example, will normally be installed on mobile station **115** during manufacturing. A preferred software application may be a personal information manager (PIM) application having the ability to organize and manage data items relating to the user of the mobile station such as, but not limited to, e-mail, calendar events, voice mails, appointments, and task items. Naturally, one or more memory stores would be available on the mobile station to facilitate storage of PIM data items. Such PIM application would preferably have the ability to send and receive data items, via the wireless network **219**. In a preferred embodiment, the PIM data items are seamlessly integrated, synchronized and updated, via the wireless network **219**, with the mobile station user's corresponding data items stored or associated with a host computer system. Further applications may also be loaded onto the mobile station **115** through the network **219**, an auxiliary I/O subsystem **228**, serial port **230**, short-range communications subsystem **240** or any other suitable subsystem **242**, and installed by a user in the RAM **226** or preferably a non-volatile store (not shown) for execution by the microprocessor **238**. Such flexibility in application installation increases the functionality of the device and may provide enhanced on-device functions, communication-related functions, or both. For example, secure communication applications may enable electronic commerce functions and other such financial transactions to be performed using the mobile station **115**.

**[0036]** In a data communication mode, a received signal such as a text message or web page download will be processed by the communication subsystem **211** and input to the microprocessor **238**, which preferably further processes the received signal for output to the display **222**, or alternatively to an auxiliary I/O device **228**. A user of mobile station **115** may also compose data items such as email messages for example, using the keyboard **232**, which is preferably a complete alphanumeric keyboard or telephone-type keypad, in conjunction with the display **222** and possibly an auxiliary I/O device **228**. Such composed items may then be transmitted over a communication network through the communication subsystem **211**, and stored in portions **251** of flash memory **224**.

**[0037]** For voice communications, overall operation of mobile station **115** is similar, except that received signals would preferably be output to a speaker **234** and signals for transmission would be generated by a microphone **236**. Alternative voice or audio I/O subsystems, such as a voice message recording subsystem, may also be implemented on mobile station **115**. Although voice or audio signal output is preferably accomplished primarily through the speaker **234**, display **222** may also be used to provide an indication of the identity of a calling party, the duration of a voice call, or other voice call related information for example.

**[0038]** Serial port **230** in FIG. **2** would normally be implemented in a personal digital assistant (PDA)-type mobile station for which synchronization with a user's desktop computer (not shown) may be desirable, but is an optional device component. Such a port **230** would enable a user to set preferences through an external device or software application and would extend the capabilities of mobile station **115** by providing for information or software downloads to mobile station **115** other than through a wireless communication network. The alternate download path may for example be used to load an encryption key onto the device through a direct and thus reliable and trusted connection to thereby enable secure device communication.

**[0039]** A short-range communications subsystem **240** is a further optional component which may provide for communication between mobile station **115** and different systems or devices, which need not necessarily be similar devices. For example, the subsystem **240** may include an infrared device and associated circuits and components or a Bluetooth™ communication module to provide for communication with similarly-enabled systems and devices.

**[0040]** FIG. **3** is a block diagram showing two GSM/GPRS networks and a mobile station roaming between them. FIG. **3** depicts a mobile station **115** roaming between two GSM/GPRS networks **120** and **125**. This type of roaming arrangement is similar to how a GSM-only network might handle roaming, but with minor differences. In a GSM/GPRS combined network, a mobile station that supports only voice, only data, or a combination of voice and data will be treated similarly with respect to roaming between networks. A mobile station entering a given area or country can detect the GSM and GSM/GPRS networks through special RF radio channel interactions. The illustration of FIG. **3** provides a quick reference summary to describe how the process works. Roaming relationships between operators are established mainly for billing issues. Special Inter operator tariff (IoT) arrangements can be established between operators for GSM traffic only, or GSM and GPRS traffic. It is these relationships that are reflected in the PPLMN and FPLMN lists within the mobile station SIM cards.

**[0041]** GSM/GPRS Network **1** is the home network **120** for the user of mobile station **115**. The home network for the user is referred to as the home public land mobile network (HPLMN) and mobile stations registered within that network are maintained in a home location registry (HLR) **150**. HLR **150** is used to verify subscribers on the home network, and to confirm home subscribers on other networks. Each wireless network supports a range of services where each of the service access points tends to be a fixed connection, not a radio-

based connection. Fixed connections generally allow greater capacity of data throughput for a large number of service subscribers supported by a single Access Point Name (APN). In FIG. **3**, one such service is termed a home service provider **100**, as it might be the primary communications service for a given group of mobile stations **115**. Some mobile stations **115** might have a single home service provider **100**, or they might have several services **105**, **110** that they access.

**[0042]** The main components in GSM/GPRS network **125** include base station **145**, the serving GPRS support node (SGSN) **130**, the gateway GPRS support node (GGSN) **140**, the Border GGSN node **135**, the HLR (home location registry) **150** and the VLR (visitor location registry) **155**.

**[0043]** Conventionally, when mobile station **115** is within a coverage area of home network **120**, it communicates via base station **145** back through network **120** to home service provider **100**. When mobile station **115** is looking for coverage, especially when there might be several networks available, it normally checks for the HPLMN first. As the user roams to another country or region where home network **120** is no longer available, mobile station **115** scans for all available base stations **147** via received, normally radio frequency (RE), signal strengths. To one skilled in the art, it is understood that selecting a 'strong enough' RE signal strength is open to a wide range of settings and interpretations. As an example, the GSM standards specify that a signal strength of −85 dBm or more should be considered an appropriate level, for a 'strong enough' signal. However, this exact signal level is not essential, to the systems and methods described herein, and other values may be useful, depending upon the particular network, mobile station or type of network or mobile station.

**[0044]** Those skilled in the art will appreciate that such scanning processes have pre-defined patterns. In a GSM or GPRS network, for example, scanning operations are defined in the standards governing GSM mobile stations. There is some flexibility in the standards, allowing a user to have some participation in the selection of a network to be used outside of the HPLMN. Each network is defined as a PLMN, and the relationship between PLMNs can be defined in tables within mobile station **115**. Once mobile station **115** has identified base stations **147** and thus the networks within its range, it turns to the PPLMN list to see if one of the networks matches a network in the PPLMN list.

**[0045]** In conventional GPRS mobile stations, there are two types of PPLMN lists within the mobile station **115**, namely an O-PPLMN and a U-PPLMN as shown in FIG. **2**. The user-defined list is a relatively new concept and is in limited use at the current time. Similarly, mobile station **115** also has a Forbidden PLMN (FPLMN) list which it uses to exclude certain network connections. There is also a chance that a network located during a scanning operation does not fall into either of these lists. In this case, the network can preferably still, be used in response to a confirmation by a mobile station user, through a dialog box for example, as to which network should be used.

**[0046]** GPRS networks are normally linked through a GPRS routing exchange (GRX) **160** and a border GGSN **135** and **137**. The signaling involved with this exchange is described herein to the extent necessary to illustrate aspects of the invention. Further details of GRX **160** may be apparent to those skilled in the art, and can also be found in the GSM standards documents dealing with support for roaming in GPRS (3GPP specification 23.122).

**[0047]** When mobile station **115** experiences a prolonged out-of-coverage situation, it begins to look for RF signals from base stations **145** or **147**. Once a signal is acquired, the radio protocols inform mobile station **115** which network has been reached and the capabilities of that network. Each network has a signature, and a GPRS-capable base station has an extended handshake protocol beyond the GSM protocol to identify its data capabilities. Within a GSM/GPRS network there exists a mobile country code (MCC) and a mobile network code (MNC) which contains a network assigned value and an access technology number. The access technology number indicates the radio frequency range of the network, i.e. 900 MHz, 1800 MHz, 1900 MHz, etc.

**[0048]** As mobile station **115** selects a network, it performs an "attach" to the network and provides its identification code. For GSM/GPRS, this code could include both the International Mobile Subscriber Identity (IMSI) or Temporary Mobile Subscriber Identity (TMSI), which identify a communication network account or subscription, and a Mobile Station ISDN/PSTN Number MSISDN, which identifies the mobile station user or subscriber. If mobile station **115** is attempting to attach to a network other than its home network **120**, such as network **125**, then the other network **125** will use the GRX network **160** to verify the subscription with home network **120**. This causes home network **120** to reference HLR **150** to determine if the subscription is valid. Once verified, mobile station **115** is placed in VLR table **157** of visiting network **125**. To one skilled in the art, this procedure is similar in a GSM-only network, except that the link between the home and visiting networks would be through a Gateway Mobile Switching Center (MSC) component.

**[0049]** After attaching to network **125**, mobile station **115** will attempt to open a Packet Data Protocol (PDP) context to home service provider **100** through the local SGSN **132** in GSM/GPRS network in country-**2** **125**. The PDP context targets an APN and home service **100**. The PDP context also allocates an IP address for mobile station **115** so that IP packets can be transmitted in either direction. SGSN **132** detects mobile station **115** as a visiting mobile station **115** and routes the request through border GGSN **137** and onward to the correct GRX connection in GRX network **160** to a corresponding border GGSN **135** in home network **120**. As mentioned above, this determination is made by the identification information provided by mobile station **115** during the attach process.

**[0050]** Each interface in the GSM/GPRS network is labeled to identify which protocol is used. Between all base stations **145** and SGSN **130**, is the Gb interface. Between SGSN **130** and GGSN **140** is the Gn interface, which is also used between SGSN **130** and border GGSN **145**. Between GGSN **140** and all service providers, the G**1** interface is used, and between border gateways **135** and GRX network **160**, the Gp interface is used. From GRX network **160**, all other foreign network operators (FNO) systems **165** can be reached, assuming they have commonly linked GRX networks.

**[0051]** GSM network standards specify particular steps that mobile station **115** must perform to select a base station **147** in GSM/GPRS network in country-**2** **125**. First, mobile station **115** must achieve a certain minimum level of signal strength with the base station. Once signal strength is established and the networks associated with each base station which meet the minimum signal strength criterion are identified, mobile station **115** uses its PPLMN and FPLMN lists on the SIM to determine what it considers the "best" network

choice. Mobile station **115** checks the PPLMN list to see if one of the newly located networks matches a network on the PPLMN list. Similarly, mobile station **115** also checks the FPLMN list to determine which networks are forbidden. If any of the newly located networks occur in the FPLMN, then those networks are excluded from any further connection operations. If there are no matches to the PPLMN list, mobile station **115** may attempt to select one of the recently located networks based on signal strength.

**[0052]** FIG. **4** is a block diagram illustrating a mobile station in a region where there are several networks of different types. In FIG. **4**, mobile station **115** is shown in a region with four networks **210**, **215**, **220**, **225**, each having a base station **212**, **214**, **216**, **218**. For illustrative purposes, it is assumed that each base station **212**, **214**, **216**, **218** has similar RF strength from the point of view of mobile station **115**, and that mobile station **115** receives "strong enough" signals, from Local Network **1 210**, Local Network **2 215**, Local Network **3 220**, and Local Network **4 225**. Two of the networks **210** and **215** are GPRS capable and two of the networks **220** and **225** are GSM-only networks that are not GPRS capable.

**[0053]** According to the present application, in order for mobile station **115** to maximize its capabilities as a multi-functional mobile station (e.g. capable of both data and voice communication services), it should select one of the GPRS networks **210** and **215**. In conventional GSM operation, mobile station **115** would compare all networks from which received signals are above any minimum required signal strength level and match them against the top-most network found in the PPLMN. Since the PPLMN is in priority order, a GSM mobile station must, by definition, follow the ordering of this list. In FIG. **4**, for example, if Local Network **4 225** is the highest network listed in the PPLMN list then mobile station **115** must camp on this network. However, this process ignores the fact that mobile station **115** might also be data-capable. The choice of Local Network **4 225**, which does not support data communications, may therefore not always be optimal for mobile station **115**.

**[0054]** To improve the capabilities of mobile station **115**, the search for a better network preferably takes other factors into consideration. Since mobile station **115** cannot effectively communicate when signal strength is below a certain level, only network base stations with 'strong enough' signals are located, substantially as described above. According to one aspect of the invention, data-capable networks, such as GPRS networks, are then identified. Mobile station **115** may then determine which of the identified data-capable networks is listed first on a preferred network list, which in GSM/GPRS mobile stations would be the PPLMN list. Mobile station **115** then checks to ensure that an interconnection, such as a GRX network for a GPRS network, is available to the home network from this highest-priority data-capable network on the preferred list. If no interconnection to the home network from the highest priority data-capable network is available, then mobile station **115** continues to try the identified data-capable networks that are also in the preferred list until a link is found back to the home network.

**[0055]** If no links can be found that connect to the home network, then mobile station **115** may revert to traditional network selection of a non-data-capable network such as a GSM network, as described above. Alternatively, the network selection method might stop after scanning all data-capable networks for links to the home network. This may be particularly desirable when the data-capable networks have more capabilities compared to a non-data-capable network. In some circumstances, even if a user cannot reach their home network, they may be able to better use the mobile station on the new network, for example, to access the Internet at large.

**[0056]** Referring again to FIG. **4**, mobile station **115** normally has access to a preferred network list in the form of a PPLMN stored on a SIM card. Data-capable networks include the GSM/GPRS Local Networks **1** and **2**, **210** and **215**, whereas the GSM Local Networks **3** and **4**, **220** and **225**, represent examples of non-data-capable networks.

**[0057]** If mobile station **115** performs the network selection method described briefly above, and it is assumed that the PPLMN list follows the ordering of the networks shown in FIG. **4**, the first network that should be attempted is the Local Network **1 210**. However, since Local Network **1 210** does not have a GRX connection back to the home PLMN **205**, Local Network **2 215** will be tried next. Since this network does have a Gp link **240** back to home PLMN **205** and home service provider **200**, it will be selected by mobile station **115**. If Local Network **2 215**, the last available data-capable network, did not have a connection back to home PLMN **205**, the first GSM network would be tried. The first GSM network tried would be Local Network **3 220**, and link **230** would be used to communicate with the HLR in that home PLMN **205** to verify the user's account information. If that fails, Local Network **4 225** would be tried via link **235**.

**[0058]** In another embodiment of FIG. **4**, the new networks **210**, **215**, **220**, **225** are not included on the O-PPLMN list on mobile station **115**. This situation is more difficult, as the U-PPLMN list may come into effect, if it exists, in a memory such as the Flash memory **224** or the RAM **226** (FIG. **2**).

**[0059]** One common way to build up a U-PPLMN is through previous user or "manual" network selections. As in the above example of FIG. **4**, it is assumed that mobile station **115** has entered a country or region where it receives signals of similar strengths from the four networks **210**, **215**, **220** and **225**. However, it is further assumed that these networks are not found on the O-PPLMN list or the FPLMN list, so mobile station **115** may consider them to be usable. In this situation, once these networks are identified, the user may be prompted to choose which network they would like to try. In the GSM standards documents, this is referred to as manual network selection. After the user has selected a network, it is tried for connectivity back to home network **205** and, if successful, it is added to the U-PPLMN.

**[0060]** The user interface (UI) to these manual network selections could be a standard dialog box, a pick list, a scrolling menu, or any other UI selection models available. It will be apparent to those skilled in the art that the UI could also include the network capabilities by showing capability identifying strings such as "GPRS" or "GSM" beside each of the network choices for the user. In another embodiment, the user might be presented with a dialog box entitled "GPRS Network Selections" followed by "GSM Network Selections" if all the GPRS networks failed to reach the home PLMN.

**[0061]** Network selection in this situation could instead be automatic, not requiring user intervention. In such a method, mobile station **115** preferably identifies the networks that support GSM and those that support GSM/GPRS and separates the two types of networks. The GSM-only networks are placed on a Discouraged PLMN list (DPLMN) and are only tried after all the GSM/GPRS networks have been tried and failed. The only failure mentioned thus far was around the inability to reach home PLMN **205**. Other failures could

include: (1) PLMN not allowed; (2) roaming not allowed in this local area; (3) GPRS not allowed; or (4) home network rejection. These errors and others might cause the network to be placed on the FPLMN, as the network link does not seem to be working for mobile station **115**.

**[0062]** Manually or automatically selected networks are preferably added to the U-PPLMN list, which may be stored in a writable data store such as Flash memory **224** or RAM **226** (FIG. **2**) in mobile station **115**. The U-PPLMN list may then be consulted during subsequent network selection procedures. Normally, mobile station **115** will first check the O-PPLMN list for new networks detected during a network selection process before consulting the U-PPLMN list. It may also be possibly to configure a mobile station to check the U-PPLMN list before the O-PPLMN list, depending, for example, upon restrictions controlled by the home network operator, a home service provider, or a mobile station owner.

**[0063]** According to current GSM standards documents, a mobile station has only the limited ability to rescan for a network that is higher in priority on the U-PPLMN list or the O-PPLMN list. If a voice-only GSM or otherwise limited service has been established for a mobile station, however, it may be desirable for the mobile station to periodically check for a new network such as a GSM/GPRS network. This may be done even if the network has a lower priority on the O-PPLMN and U-PPLMN lists. This situation may also arise for other types of mobile stations and networks, where a mobile device is enabled for communications over different types of networks which support different mobile station functions or services.

**[0064]** In FIG. **4**, mobile station **115** enters a new region or country and finds coverage (i.e. a 'strong enough' signal) with only one GSM-only base station located on Local Network **4 225**. However, as mobile station **115** travels within the same country it may come into coverage of another GSM/GPRS base station, in Local Network **1 210**. In GSM standards, mobile station **115** could only camp on the network **210** if it had higher priority in the PPLMN lists. In accordance with the present application, however, mobile station **115** will attempt to rescan for other data-capable networks not previously seen or available upon expiration of a time period or other suitable event. This includes any network that may be lower in priority on the O-PPLMN and U-PPLMN lists. This time interval may be specified or configured by a network operator, SIM manufacturer, network standards documents, mobile station manufacturers, or a user of mobile device **115**, as examples. The goal of such rescanning is to improve the network capabilities of mobile station **115**. In this example, mobile station **115** has voice support through the Local Network **4 225**, but by changing network connections mobile station **115** could obtain data and voice support through Local Network **1 210**.

**[0065]** A rescanning process may be triggered or initiated by any suitable event. For example, in the case of an interval timer, a rescanning process may be executed whenever a rescan timer expires. Such a timer is reset appropriately so that rescanning is performed at intervals. If the timer is reset to the same value unless or until the time interval is reconfigured, rescanning will occur at regular intervals. Rescan timing could instead be repeated at different intervals, if the timer is reset to different values after some number of unsuccessful, rescan operations during which no new data-capable network is found. In order to avoid rescanning at typically high network traffic times, rescanning could also be restricted during certain times of day. Rescanning could also or alternatively be performed when a mobile station detects a change in regions, or when a mobile station acquires a voice-only network connection in new region. If the mobile station detects an available network capable of both voice and data communications, then the mobile station preferably attempts to camp on this network. Received signal strengths and PPLMN lists may be used substantially as described above during a rescan process. Since a primary goal of the rescanning process is to find an available data communication service for the mobile station, rescanning is preferably disabled when a mobile station is already operating within a network which has the data communication service already available.

**[0066]** When a current network is on the O-PPLMN list or the U-PLMN list, and a newly discovered network is not on the PPLMN list, the mobile station may remain on the current network instead of switching to a new network. It is likely that most GSM/GPRS networks have been included somewhere on the O-PPLMN list or possibly the U-PPLMN list. A network change during a rescan process may also be dependent upon relative signal strengths to avoid switching from a strong GSM network to a significantly weaker GSM/GPRS network. Acceptable signal strength differences may be stored, for example, in a memory of a mobile station.

**[0067]** Time-Efficient Selection Of Data-Capable Networks For Data-Capable Mobile Devices. Thus, a better and non-traditional network selection technique for data-capable mobile stations involves prioritizing the selection of data-capable communication networks (e.g. GPRS) over voice-only networks (e.g. GSM). In such a procedure, the mobile station may have to determine whether or not the data service is actually made available by the communication network. Conventionally, a mobile station makes a request for a data service which may be accepted or denied by the network. When data service is denied, the mobile station receives different "reject cause codes" from the network which are associated with different reasons for service denial. Depending on the reject code, the mobile station may have to wait until it may request the data service again, a timer expires, the network changes, or the user cycles the power (off & on) of the mobile device. If the end user is not viewing the display of the mobile station (e.g. the mobile station is carried in a holster), the user will not be aware of the data service unavailability and may not receive important push data in a timely fashion (e.g. pushed e-mail messages). In a related efficiency problem, if the GPRS attach or a Routing Area Update (RAU) attempt is not successful with the network (e.g. no network response, or the receipt of a rejection code), the mobile station consecutively reattempts for up to five (5) times. If the GPRS attach or RAU attempt counter is greater than or equal to five, the mobile station must place itself into a "GPRS Deregistered" state and start a timer designated as "timer **3302**". Timer **3302** is set to a value taken from GSM timer **3212**, which is a periodic location update timer. See e.g. 3GPP specification 4.08 Release 1997. From 3GPP specification 24.08 Release 1999, the default value of T3302 is 12 minutes if one is not provided by the network. The mobile station ordinarily receives the value for timer **3212** over-the-air by the network or, if one is not provided by the network, utilizes a default value. If provided over-the-air by the network, the timer may be set to up to four (4) hours. The mobile station is not able to attempt for GPRS services again until this timer **3302** expires. As apparent, this may cause substantial data delays (e.g. delays in receiving "pushed" e-mail messages).

**[0068]** FIGS. **5**, **6**, and **7** form a flowchart which describes a specific method of automatic network selection performed by a mobile station. This method includes a more time-efficient selection of a data-capable network according to the present application, so as to overcome the deficiencies of conventional techniques. A computer program product of the present application includes a storage medium and computer instructions stored in the storage medium, where the computer instructions are executable by one or more processors of a mobile station for performing the method described. The mobile station of the present application includes one or more processors and a wireless transceiver coupled to the one or more processors, where the one or more processors are operative to perform the method described.

**[0069]** Beginning at a connector M of FIG. **5**, where the mobile station gets powered on or recovers from an out-of-coverage condition, a scanning operation identifies available networks within the mobile station's coverage area. From the scan list, the mobile station identifies whether or not there is a Registered PLMN (RPLMN) (step **502**). An RPLMN is only acknowledged as an RPLMN if it had a data connection (e.g. GPRS connection); otherwise the RPLMN is not acknowledged as an RPLMN. If there is an RPLMN in step **502**, then the mobile station identifies whether there is a Home PLMN and whether that HPLMN is not the same as the RPLMN (step **504**). If "YES" at step **504**, the mobile station selects the HPLMN (step **506**) in this case where the RPLMN is available and the HPLMN is available and allowable. If "NO" at step **504**, the mobile station selects the RPLMN (step **508**). After step **508**, and after step **506** where the mobile station selects the HPLMN, the mobile station attempts registration with the selected PLMN (step **510**). Note that a connector P' leads to step **510** as well. By "available", it is meant that the network is available in the coverage area of the mobile station; by "allowable", it is meant that the network provides at least GSM service (e.g. obtained through a GSM attach procedure).

**[0070]** Upon an unsuccessful registration at step **510** (i.e. a GSM attach reject), the mobile station receives a reject code from the network. The reject code is tested and, if the reject code has a value of 2, 3, or 6 (step **521**), then the mobile station proceeds to step **523**. In step **523**, the mobile station tests whether the reject code has a specific value of 2. If the reject code=2 in step **523**, then the mobile station records that the network is preferred as GPRS (step **527**) where the flow continues through a connector O. If the reject code does not have a value of 2 as identified in step **523**, then the SIM is designated as invalid until power off or SIM card removal (step **525**). If the reject code does not have a value of 2, 3, or 6 at step **521**, then the flow proceeds to step **522**. Upon a successful registration at step **510** (i.e. a GSM attach accept), the selected PLMN is indicated in a visual display of the mobile station (step **512**). From step **512**, the mobile station identifies in step **540** whether the PLMN is GSM-only (i.e. no data service). If "YES" in step **540**, the mobile station remains registered and connected through this PLMN (state **542**). In state **542**, the mobile station may experience an out-of-coverage condition where operation proceeds through a connector R**1**. On the other hand, in state **542** the mobile station may receive a user manual, reselection of a network and thereafter proceed through a connector S (FIG. **6**). Further in step **542**, operation through connector P**2** may lead to step **528**, where the mobile station identifies whether the PLMN is not the HPLMN and the HPLMN timer is greater than 6 minutes. If "YES" at step **528**, then the mobile station starts an internal timer t**1** for a PLMN search (step **530**). If "NO" at step **528**, the mobile station waits for the HPLMN timer to timeout (step **532**). Upon timeouts in steps **530** and **532**, the mobile station identifies whether the HPLMN or a data-capable (e.g. GPRS capable) PLMN was found (step **534**). If "YES" at step **534**, then operation proceeds through a connector Z. If "NO" at step **534**, then operation continues in state **542**.

**[0071]** If "NO" from step **540**, then operation proceeds to step **514**. In step **514**, the mobile station attempts a GPRS attach request with the selected network (step **514**). If successful at step **514**, the mobile station attempts a PDP context request with the selected network (step **516**). If successful at step **516**, the mobile station remains registered and connected through this PLMN (state **518**). Note that a connector W leads to state **518** as well. Note also that connector O leads to step **514**, and a connector X**1** leads to step **516**. In step **514**, the mobile station may receive a reject code from the network in response to the GPRS attach request and thereafter proceed through a connector T (FIG. **6**). On the other hand, in step **514** there may be a T3310 timer timeout or a low layer failure where operation proceeds through a connector V (FIG. **6**). In step **516**, the mobile station may receive a reject code from the network in response to the PDP context request and thereafter proceed through a connector U (FIG. **7**). On the other hand, in step **516** there may be a T3380 timer timeout where operation proceeds through a connector U**1** (FIG. **7**).

**[0072]** In state **518**, the mobile station may receive a user manual reselection of a network and thereafter proceed through a connector S (FIG. **6**). Also in state **518**, the mobile station may experience a Routing Area Update (RAU) rejection and thereafter proceed through a connector T (FIG. **6**). Further in state **518**, the mobile station may experience a RAU T3330 timeout or a lower layer failure and thereafter proceed through a connector V (FIG. **6**). Even further in state **518**, if the current PLMN is not the HPLMN, a periodic HPLMN timer expiration invokes the mobile station to identify whether the HPLMN or data-capable PPLMN is now available (step **520**). If the HPLMN or a data-capable PPLMN is available in step **520**, the operation proceeds through a connector P'. If the HPLMN or a data-capable PPLMN is not available in step **520**, the mobile station remains registered and connected through the PLMN in state **518**. Yet even further in state **518**, a PDP deactivation from the network leads operation through connector U**2**.

**[0073]** In state **518**, the mobile station may also experience an out-of-coverage condition with the PLMN and thereafter proceed to step **522**. Step **522** is also performed if there is no RPLMN identified in step **502**, or a GSM attach reject < > 2 is identified from step **521**, or a radio coverage loss is experienced from state **542** (through connector R**1**). In step **522**, the mobile station identifies whether there is any PLMN available and allowable. If there is any PLMN available and allowable, the operation proceeds through a connector R (FIG. **6**). If there is no PLMN available and allowable at step **522**, then the mobile station will display "No Allowable Network—Emergency Service Only" (where other networks are available but not allowable) (step **524**). If there is no available network at step **522**, then the mobile station will display "Out-Of-Coverage—No Service" in step **524**. Note that a connector Q leads to step **524** as well. After step **524**, the mobile station will wait for PLMNs to become available (state **526**). If the RPLMN becomes available and allowable in state **526**, then operation proceeds through connector P'. If a non-RPLMN becomes available and allowable in state **526**, then operation proceeds through connector R.

**[0074]** Reference will now be made to FIG. **6**, which continues with the automatic network selection and particularly describes the handling of reject codes from networks in response to GPRS attach requests from a mobile station. Connector T is from step **514** of FIG. **5**, where the network sends a reject code to the mobile station in response to a GPRS attach request. If the reject code has a value of 3, 6, or 8 as identified in step **601**, then the SIM is designated as invalid until power off or SIM card removal (step **603**). If the reject code does not have a value of 3, 6, or 8 as identified in step **601**, then flow proceeds to step **602**. If the reject code has a value of 7, 11, 12, 13, or 14 in step **602**, the rejection is deemed critical and operation proceeds to step **614** where the mobile station will generally immediately proceed to reselect a different network. If the reject code has any other value (i.e. not 7, 11, 12, 13, or 14) as tested in step **602**, the rejection is deemed non-critical and operation proceeds to step **604** where the mobile station will generally reattempt with the network. Note that a critical error is deemed one in which a permanent problem or fault exists with the network or the end user's service subscription; a non-critical error is not critical but rather is one in which there is a problem or fault with the network or service subscription that may be passing or temporary. A reject code having a value of 3 corresponds to an illegal mobile station; a value of 6 corresponds to an illegal mobile equipment; and a value of 8 corresponds to GPRS services and non-GPRS services not being allowed. A reject code having a value of 7 corresponds to GPRS services not allowed; a value of 11 corresponds to PLMN not allowed; a value of 12 corresponds to location area not allowed; a value of 13 corresponds to roaming not allowed in the current location area; and a value of 14 corresponds to GPRS services not allowed by the current PLMN.

**[0075]** In step **604**, the mobile station checks an attach counter (or RAU counter) to see if its value is greater than or equal to five (5). Note that a connector V leads to step **604** as well. If the attach counter (RAU counter) is not greater than or equal to five, then operation proceeds through connector O (if attach reject/no network response) or connector W (if RAU reject/no network response) (FIG. **5**). If the attach counter (RAU counter) is greater than or equal to five, then the mobile station proceeds to check whether the PLMN is the HPLMN (step **620**). If the PLMN is the HPLMN at step **620**, then the mobile station displays "Temporary Failure of Data Service" (step **622**) and proceeds to check whether a timer T**3302** is set to a value that is greater than a predetermined internal timer value (step **606**). The internal timer value is typically set to between 5-30 minutes, and preferably greater than 12 minutes (e.g. between 13 and 30 minutes). Alternatively, the internal timer value is set to between 5-10 minutes, preferably about 6 minutes. If timer T3302 is greater than the internal timer value at step **606**, the mobile station starts a timer based on the internal timer value (step **608**). If timer T3302 is greater than the internal timer value at step **606**, the mobile station starts a timer based on the timer T3302 value (step **612**). Upon timeout from either of the timers at steps **608** and steps **612**, then operation proceeds through connector O (if attach reject/no network response) or connector W (if RAU reject/no network response).

**[0076]** In step **614**, the mobile station detects whether the current PLMN is the HPLMN. If the current PLMN is the HPLMN, then operation proceeds to step **616**. In step **616**, the mobile station displays "Data Service Refused on this Network—Please Contact your Service Provider" (step **616**). If the current PLMN is not the HPLMN at step **614**, then the mobile station operates to scan for a new network (step **618**). Step **618** is also performed in response to a "NO" decision at step **620** previously described above. After step **618**, the mobile station identifies whether there are any data-capable (i.e. GPRS capable) PLMNs available and allowable (step **624**). If there are data-capable PLMNs available and allowable, then the mobile station configures and marks the PLMN list accordingly (step **638**). For example, PLMNs that are data-capable may be flagged as preferred in the PLMN list. Note that connector Z leads to step **638** as well. Next, the last selected PLMN is moved into the last position of the PLMN list (step **640**) (with the exception of the HPLMN which is placed "second" in the list). Note that connector S leads to step **640** as well. The first PLMN in the PLMN list is then selected by the mobile station (step **642**). Note that connector R also leads to step **642**. The mobile station then identifies whether its SIM is invalid for GSM service (step **643**). If the SIM is invalid for GSM service at step **643**, then operation proceeds through a connector O (FIG. **5**). If the SIM is not invalid for GSM service at step **643**, then operation proceeds through a connector P' (FIG. **5**).

**[0077]** In step **624** if there are no data-capable PLMNs available, then the mobile station displays "Data Service Refused on this Network" (step **654**) and proceeds to step **628**. In step **628**, the mobile station checks whether the HPLMN timer is greater than 6 minutes. If the HPLMN timer is greater than 6 minutes, the mobile station starts an internal timer t**1** for PLMN search (step **632**). If the HPLMN timer is not greater than 6 minutes, the mobile station waits for the HPLMN timer to timeout (step **630**). When a timeout occurs from either step **630** or **632**, the mobile station identifies whether the HPLMN or a GPRS PLMN has been found (step **634**). This PLMN must not have been previously rejected with a reject code of 7, 12, 13, or 14. If "YES" at step **634**, then operation proceeds through a connector Z. If "NO" at step **634**, then the mobile station starts the HPLMN timer or internal timer t**1** (step **636**).

**[0078]** Reference will now be made to FIG. **7**, which continues with the automatic network selection and particularly describes the handling of reject codes from networks in response to PDP context requests from a mobile station. Connector U**2** is from step **518**, where the network sends a PDP deactivation to the mobile station. Connector U is from step **516** of FIG. **5**, where the network sends a reject code to the mobile station in response to a PDP context request. From connector U and U**2**, the mobile station tests whether the current APN is not a "X.net" type APN (i.e. a predetermined address) or does not support e-mail service (step **700**). If "YES" at step **700**, then the mobile station remains on the current network (step **701**). If "NO" at step **700**, then the flow proceeds to step **702** where the mobile station tests the reject code received from the network. A reject code is an indication that the network has rejected the request for data connectivity for some reason. If the reject code is deemed non-critical (step **702**), then operation proceeds to step **704** where the mobile station will generally reattempt with the network. If the reject code is deemed critical at step **702**, then operation proceeds to step **706** where the mobile station will generally reselect a different network.

**[0079]** In the present embodiment, reject codes that are deemed non-critical are **26**, **31**, **34**, **102**, **38**, **36**, **39**, and **35**. Reject code **26** corresponds to insufficient resources; reject code **31** corresponds to an unspecified activation rejection;

reject code **34** corresponds to the service option being temporarily out-of-order; reject code **102** corresponds to a timeout from no response from the network; reject code **38** corresponds to a network failure; reject code **36** corresponds to a regular PDP context deactivation; reject code **39** corresponds to a reactivation request; and reject code **35** corresponds to the NSAPI already being used. On the other hand, reject codes that are deemed critical are **27**, **29**, **30**, **32**, **33**, and **25**. Reject code **27** corresponds to a missing or unknown APN; reject code **29** corresponds to a user authentication failure; reject code **30** corresponds to the activation being rejected by the GGSN; reject code **32** corresponds to the service option being unsupported; reject code **33** corresponds to the service option not being subscribed to; and reject code **25** corresponds to an LLC or SNDCP failure.

**[0080]** In step **704**, the mobile station checks whether the PDP attempt counter is greater than or equal to five (5). Note that connector U**1** leads to step **704** as well. If the PDP attempt counter is not greater than or equal to five, then operation proceeds through a connector X**1**. If the PDP attempt counter is greater than or equal to five, the mobile station tests whether the reject code has a value of "102" (step **705**). If the reject code has a value of "102", then the mobile station sends a detach request to the network (step **707**) and proceeds through a connector O. If the reject code does not have a value of "102" at step **705**, then the mobile station checks whether the current PLMN is the HPLMN (step **706**). Step **706** is also performed if the mobile station identifies that the reject code is indeed a critical error from step **702**. If "YES" at step **706**, then operation proceeds to step **708**. In step **708**, the mobile station displays "Data Connection Temporarily Failed" if the error is non-critical or "Data Connection Refused on Network—Please Contact Your Service Provider" if the error is critical (step **708**). If "NO" at step **706**, the mobile station scans to identify available networks (step **710**). The mobile station then identifies whether there are any data-capable (e.g. GPRS-capable) PLMNs allowable and not having an unsuccessful PDP context (step **712**). If there is a data-capable PLMN available, then operation proceeds through connector Z. If there is no data-capable PLMN available, then the mobile station displays "Data Connection Refused" if the error is non-critical or "Data Connection Refused—Please Contact Your Service Provider" if the error is critical (step **714**).

**[0081]** Next, the mobile station checks whether the HPLMN timer is greater than 6 minutes (step **720**). If the HPLMN timer is greater than 6 minutes, the mobile station starts an internal timer t**1** for PLMN search (step **718**). If the HPLMN timer is not greater than 6 minutes from step **720**, the mobile station waits for the HPLMN timer to timeout (step **722**). Note that connector W**1** leads to step **722** as well. When a timeout occurs, the mobile station identifies whether the HPLMN or a data-capable (e.g. GPRS capable) PLMN has been found (step **724**). If the HPLMN or data-capable PLMN is found, then operation proceeds through a connector Z. If no HPLMN or data-capable PLMN is found, then the mobile station starts the HPLMN timer or internal timer t**1** (step **726**).

**[0082]** Preferably, an indication is made in memory of the mobile station of whether the wireless network currently makes the voice and data connectivity available to the mobile station. The indication for the wireless network may be indicative of "currently available data connectivity" if the request for data connectivity is accepted by the wireless network, or indicative of "currently unavailable data connectivity" if the reject code comprising the critical error is received or if the one or more requests for data connectivity through the wireless network are reattempted without success. Similar results may be achieved through use of a list of currently unavailable data connectivity networks stored in memory. Such a list includes the wireless network if the reject code comprising the critical error is received or if the one or more requests for data connectivity through the wireless network are reattempted without success; however the list fails to include the wireless network if the request for data connectivity is accepted by it.

**[0083]** FIGS. **8**, **9**, and **10** form a flowchart which describes a specific method of manual network selection provided by a mobile station for an end user. This method also includes a more time-efficient selection of a data-capable network according to the present application, so as to overcome the deficiencies of conventional techniques. A computer program product of the present application includes a storage medium and computer instructions stored in the storage medium, where the computer instructions are executable by one or more processors of a mobile station for performing the method described. The mobile station of the present application includes one or more processors and a wireless transceiver coupled to the one or more processors, where the one or more processors are operative to perform the method described.

**[0084]** Beginning at a connector A of FIG. **8**, where the mobile station gets powered on or recovers from an out-of-coverage condition, a scanning operation identifies available networks within the mobile station's coverage area. From the scan list, the mobile station identifies whether or not there is a Registered PLMN (RPLMN) (step **802**). An RPLMN is only acknowledged as an RPLMN if it had a data connection (e.g. GPRS connection); otherwise the RPLMN is not acknowledged as an RPLMN. If there is an RPLMN in step **802**, then the mobile station identifies whether there is a Home PLMN and whether that HPLMN is not the same as the RPLMN (step **804**). If "YES" at step **804**, the mobile station displays "Select HPLMN" (step **806**) in this case where the RPLMN is available and the HPLMN is available and allowable. If "NO" at step **804**, the mobile station selects the RPLMN (step **808**) and attempts registration ("GSM attach") with it (step **810**). If the end user selects "YES" in step **806** for selection of the HPLMN, then flow proceeds through a connector F to step **810**. If the end user selects "NO" in step **806**, then flow proceeds to step **808**.

**[0085]** If the GSM attach is accepted at step **810**, the selected PLMN is indicated in a visual display of the mobile station (step **812**). Step **812** is also performed through a connector G as well. Next, the mobile station identifies whether the PLMN is GSM-only (i.e. no data service) (step **850**). If "NO" at step **850**, then operation leads to step **814** to be described later. If "YES" at step **850**, then the mobile station remains registered and operates on this PLMN (state **852**). Note that a connector G**2** leads to state **852**. In state **852**, the mobile station may receive a user manual selection of a network and thereafter proceed through a connector C. Also in state **852**, if the mobile station identifies that the current PLMN is GSM-only and any GPRS PLMN becomes available, operation proceeds to step **854** where the mobile station displays "Select GPRS Network?". If the end user selects "YES" for this option, then operation proceeds through connector G**1**; otherwise operation proceeds through connector

G2. Further in state **852**, the mobile station may experience an out-of-coverage condition with the PLMN and thereafter proceed through connector C1.

**[0086]** If the GSM attach was rejected in step **810**, the mobile station receives a reject code from the network. This reject code is tested and, if the reject code has a value of 2, 3, or 6 (step **855**), then the flow continues to step **857**. If the reject code has a specific value of 2 as identified in step **857**, then flow continues through a connector B2. If the reject code does not have a specific value of "2" in step **857**, then the SIM is designated as invalid until power off or SIM card removal (step **859**). If the reject code does not have a value of 2, 3, or 6 as identified in step **855**, then the mobile station displays "Emergency Service Only" (step **856**) and continues to step **821**. Note that a connector H1 leads to step **856** as well. Next, the mobile station identifies whether any PLMNs are available (step **821**). If no PLMNs are available at step **821**, the mobile station waits for any PLMNs to appear (step **858**) and proceeds through connector H when one does. If one or more PLMNs are available at step **821**, the mobile station proceeds to step **828** to be described later.

**[0087]** If in step **850**, the mobile station identifies that the PLMN is not GSM-only (i.e. it may offer data service), then the mobile station attempts a GPRS attach request with the selected network (step **814**). Note that a connector B2 leads to step **814** as well. If successful at step **814**, the mobile station attempts a PDP context request with the selected network (step **816**). If successful at step **816**, the mobile station remains registered and connected through this PLMN (state **818**). Note that a connector B3 leads to state **818** as well.

**[0088]** In step **814**, the mobile station may receive a reject code from the network in response to the GPRS attach request and thereafter proceed through a connector B (FIG. **9**). On the other hand, in step **814** there may be a T3310 timer timeout where operation proceeds through a connector B' (FIG. **9**). In step **816**, the mobile station may receive a reject code from the network in response to the PDP context request and thereafter proceed through a connector X (FIG. **10**). Also in step **816**, there may be a T3380 timer timeout where operation proceeds through a connector X2. Note also that a connector X3 leads to step **816** as well. In state **818**, the mobile station may receive a user manual selection of a network and thereafter proceed through a connector C. Also in state **818**, the mobile station may experience a Routing Area Update (RAU) rejection and thereafter proceed through a connector B (FIG. **9**). Further in state **818**, the mobile station may experience a RAU T3330 timeout and thereafter proceed through a connector B' (FIG. **9**). Further in state **818**, the mobile station may receive a PDP deactivation by the network and thereafter proceed through connector C2. Yet even further in state **818**, the mobile station may experience an out-of-coverage condition with the PLMN and thereafter proceed to step **820**. Step **820** is also performed if there is no RPLMN identified in step **802**.

**[0089]** In step **820**, the mobile station identifies whether there is any PLMN available. If there is no PLMN available at step **820**, then the mobile station displays "No Service" (step **826**). The mobile station will then wait for any PLMNs to appear (step **862**). If the previously selected PLMN becomes available in step **862**, then operation proceeds through a connector F; otherwise if any other PLMN becomes available, operation proceeds through a connector H. If there is any PLMN available in step **820**, then the mobile station then displays "Select Network" for the user to choose whether to manually select a network (step **828**). Note that a connector H leads to step **828** as well. If the user selects "YES" at step **828**, the mobile station displays all available PLMNS in order and gives the user the option to select one of the PLMNs (step **830**). Note that a connector C leads to step **830** as well. Once the user selects a network in step **830**, the mobile station attempts to register with the selected PLMN. The mobile station then identifies whether the selected PLMN is a Forbidden PLMN (FPLMN), or whether there is a GPRS attach rejection, or whether there is a PDP context rejection (step **834**). If "YES" at step **834**, then operation proceeds to step **838**. If in step **838** the PLMN is the FPLMN, then the mobile station displays "Emergency Service Only. Select SAVE or CANCEL" (step **838**). If the PLMN had a GPRS attach rejection or PDP context rejection, then the mobile station displays "Voice Service Only. Select SAVE or CANCEL" (step **838**). After step **838**, if the end user selects CANCEL then operation proceeds back to step **828**. If "NO" at step **834**, then the mobile station attempts registration ("GSM attach") with the PLMN (step **860**). Note that a connector G1 also leads to step **860**. If the GSM attach is accepted at step **860**, then operation proceeds through a connector G. If the GSM attach is rejected at step **860**, then operation proceeds through a connector B4. If the end user selects "NO" in step **828**, then the mobile station displays "Emergency Service Only" and waits for the previously selected PLMN to become available again (step **832**). The mobile station will try the previously selected PLMN or wait for a previously selected PLMN to become available, where operation proceeds through a connector F.

**[0090]** Reference will now be made to FIG. **9**, which continues with the manual network selection and particularly describes the handling of reject codes from networks in response to GPRS attach requests from a mobile station. Connector B is from step **814** of FIG. **8**, where the network sends a reject code to the mobile station in response to a GPRS attach request. A reject code is an indication that the network has rejected the request for data connectivity for some reason. If the reject code has a value of 3, 6, or 8 as identified in step **901**, then the SIM is designated as invalid until power off or SIM card removal (step **903**). If the reject code does not have a value of 3, 6, or 8 in step **901**, then flow proceeds to step **902**. If the reject code has a value of 7, 11, 12, 13, or 14 as identified in step **902**, the rejection is deemed critical and operation proceeds to step **914** where the mobile station will generally prompt for manual reselection of a network. If the reject code has any other value (i.e. not 7, 11, 12, 13, or 14) as identified in step **902**, the rejection is deemed non-critical and operation proceeds to step **904** where the mobile station will generally reattempt with the network. Note that a critical error is deemed one in which a permanent problem or fault exists with the network or the end user's service subscription; a non-critical error is not critical but rather is one in which there is a problem or fault with the network or service subscription that may be passing or temporary. A reject code having a value of 3 corresponds to an illegal mobile station; a value of 6 corresponds to an illegal mobile equipment; and a value of 8 corresponds to GPRS services and non-GPRS services not being allowed. A reject code having a value of 7 corresponds to GPRS services not allowed; a value of 11 corresponds to PLMN not allowed; a value of 12 corresponds to location area not allowed; a value of 13 corresponds to roaming not allowed in the current location area; and a value of 14 corresponds to GPRS services not allowed by the current PLMN.

**[0091]** In step **904**, the mobile station checks an attach/RAU counter to see if its value is greater than or equal to five (5). Note that a connector B' leads to step **904** as well. If the attach/RAU counter is not greater than or equal to five, operation proceeds through a connector B**2** (if attach reject/no network response) or a connector B**3** (if RAU reject/no network response) (FIG. **8**). If the attach/RAU counter is greater than or equal to five, then the mobile station immediately displays "Data Service Refused on this Network" (step **906**). Next, the mobile station proceeds to check whether a timer T3302 is set to a value that is greater than a predetermined internal timer value t**2** (step **908**). The internal timer value t**2** is typically set to between 5-30 minutes, and preferably to greater than 12 minutes (e.g. between 13 and 30 minutes). Alternatively, the internal timer value is set to between 5-10 minutes, preferably about 6 minutes. If timer T3302 is greater than the internal timer value t**2** at step **908**, the mobile station starts a timer based on the internal timer value t**2** (step **912**). If timer T3302 is greater than the internal timer value at step **908**, the mobile station starts a timer based on the timer T3302 value (step **910**). Upon timeout of the timer from steps **910** and steps **912**, operation proceeds to connector B**2** (if attach reject/no network response) or connector B**3** (if RAU reject/no network response). After steps **910** and **912**, the mobile station displays "Select Network?" for the user to choose whether to manually select a network (step **916**). If the user selects "YES" at step **916**, operation proceeds through connector C. If the user selects "NO" at step **916**, the mobile station displays "Data Service Refused on this Network" (step **918**). At step **914** from earlier step **902**, the mobile station displays "Data Service Refused on this Network" and prompts for end user selection of a network. After step **914**, operation proceeds to step **916**, described previously above.

**[0092]** Reference will now be made to FIG. **10**, which continues with the manual network selection and particularly describes the handling of reject codes from networks in response to PDP context requests from a mobile station. Connector C**2** is from step **818** of FIG. **8**, where the network sends a PDP deactivation to the mobile station. Connector X is from step **816** of FIG. **8**, where the network sends a reject code to the mobile station in response to a PDP context request. If the reject code is deemed non-critical (step **1002**), then operation proceeds to step **1012** where the mobile station will, generally reattempt with the network. Note that a connector X**2** leads to step **1012** as well. If the reject code is deemed critical at step **1002**, then operation proceeds to step **1004** where the mobile station will, generally prompt for manual reselection of a different network.

**[0093]** In the present embodiment, reject codes that are deemed non-critical are **26**, **31**, **34**, **102**, **38**, **36**, **39**, and **35**. Reject code **26** corresponds to insufficient resources; reject code **31** corresponds to an unspecified activation rejection; reject code **34** corresponds to the service option being temporarily out-of-order; reject code **102** corresponds to a timeout from no response from the network; reject code **38** corresponds to a network failure; reject code **36** corresponds to a regular PDP context deactivation; reject code **39** corresponds to a reactivation request; and reject code **35** corresponds to the NSAPI already being used. On the other hand, reject codes that are deemed critical are **27**, **29**, **30**, **32**, **33**, and **25**. Reject code **27** corresponds to a missing or unknown APN; reject code **29** corresponds to a user authentication failure; reject code **30** corresponds to the activation being rejected by the GGSN; reject code **32** corresponds to the service option being unsupported; reject code **33** corresponds to the service option not being subscribed to; and reject code **25** corresponds to an LLC or SNDCP failure.

**[0094]** In step **1012**, the mobile station identifies whether the PDP attempt counter is greater than or equal to five (5). If the PDP attempt counter is not greater than or equal to five, then operation proceeds to connector X**3**. If the PDP attempt counter is greater than or equal to five, then the mobile station displays "Data Connection Refused on this Network" and prompts the user whether to manually "Select Network" (step **1004**). If the user chooses "YES" for manually selecting a network at step **1006**, then operation proceeds through connector C. If the user chooses "NO" for manually selecting a network at step **1006**, then the mobile station displays "Data Connection Refused" (step **1008**). Next, if the error is non-critical, then the mobile station starts a timer t**1**; otherwise the mobile station waits for the user to manually select a network (step **1010**). If the t**1** timer expires from step **1010**, then operation continues through connector X**3**.

**[0095]** Thus, methods and apparatus for selecting a communication network to provide one or more communication services for a mobile station have been described in detail. In general, a scanning operation is performed by the mobile station to identify one or more communication networks which support a voice communication service in a geographic coverage area. The mobile station identifies which of the identified communication networks make a data communication service available for the mobile station. The mobile station then selects and registers with a communication network that makes the data communication service available over a network that fails to make the data communication service available. Preferably, the method is performed in connection with the creation of one or more prioritized network lists. In this case, the mobile station assigns a higher priority in the prioritized network list to a communication network that makes the voice and data communication service available and allowable to it over a communication network that does not. In any event, however, the home network is maintained as the highest priority network for communication with the mobile station.

**[0096]** Advantageously, the specific techniques of the present application allow for a time-efficient selection of data-capable networks for data-capable mobile stations. One illustrative method of the present application includes the steps of causing a request for data connectivity to be transmitted through a first wireless network; reattempting the request for data connectivity through the first wireless network one or more times if a reject code comprising a non-critical error is received in response to the request for data connectivity through the first wireless network; and attempting to select a second wireless network for communications without reattempting the request for data connectivity through the first wireless network one or more times if a reject code comprising a critical error is received in response to the request for data connectivity through the first wireless network. A critical error is deemed one in which a permanent problem or fault exists with the network or service subscription associated with the end user. Conventionally, the time period between the first attempt for data connectivity through the first wireless network (including all reattempts) and the first attempt for data connectivity through the second wireless network may be between about 25 minutes and 4 hours. As apparent, the inventive techniques reduce this time period to provide for a more time-efficient selection of a data-capable network. Note that a computer program product of the present application includes a storage medium and computer instruc-

tions stored on the storage medium, where the computer instructions are executable by a processor for performing the method described above.

**[0097]** An indication may be made in memory of the mobile station of whether the wireless network currently makes data connectivity available to the mobile station. The indication for the wireless network may be indicative of "currently available data connectivity" if the request for data connectivity is accepted by the wireless network, or indicative of "currently unavailable data connectivity" if the reject code comprising the critical error is received or if the one or more requests for data connectivity through the wireless network are reattempted without success. Similar results may be achieved through use of a list of currently unavailable data connectivity networks stored in memory. Such a list includes the wireless network if the reject code comprising the critical error is received or if the one or more requests for data connectivity through the wireless network are reattempted without success; however the list fails to include the wireless network if the request for data connectivity is accepted by it. In any event, however, the home network is maintained as the highest priority network for communication with the mobile station.

**[0098]** A mobile station of the present application includes one or more processors, memory coupled to the one or more processors, and a wireless transceiver coupled to the one or more processors. The one or more processors are operative to cause a request for data connectivity to be transmitted through a first wireless network with use of the wireless transceiver; reattempt the request for data connectivity through the first wireless network one or more times if a reject code comprising a non-critical error is received in response to the request for data connectivity through the first wireless network; and attempt to select a second wireless network for communications without reattempting the request for data connectivity through the first wireless network one or more times if a reject code comprising a critical error is received in response to the request for data connectivity through the first wireless network. A communication system of the present application includes a first wireless communication network, a second wireless communication network, and a mobile station operative to select one of the first wireless communication network and the second wireless communication network for communications. The mobile station of the communication system includes the components described above.

**[0099]** It will be appreciated that the above description relates to preferred embodiments by way of example only. Many variations thereof will be obvious to knowledgeable in the field to which the invention pertains, and such variations are within the scope of the invention as described and claimed, whether or not expressly described. For example, although the detailed description has strictly used the term "network" in context of the inventive methods (which presumes substantial homogeneity inside each network), the invention also broadly includes selecting between sub-sections of networks including network subnets and even individual cells. As another example, although embodiments of the invention have placed an emphasis on GSM and GSM/GPRS networks, and voice and data-capable mobile stations, it should be appreciated that the invention is not limited to such networks, mobile stations, and services. The invention is applicable to other systems in which mobile stations are enabled for communication services available to different extents. Finally, although the mobile device oftentimes identifies a plurality of communication networks available within its geographic coverage area, it may sometimes identify only a single available network with which to act upon; this understanding should not in any way limit the interpretation of the claims.

What is claimed is:

**1**. A method for use by a mobile station in selecting a wireless communication network for communications with the mobile station, the method comprising:
- selecting a first wireless network available for communications with the mobile station;
- causing a request for data connectivity to be transmitted to the first wireless network selected;
- if a rejection is received from the first wireless network in response to the request for data connectivity:
  - reattempting the request for data connectivity to the first wireless network at least one time;
  - selecting a second wireless network available for communications with the mobile station after the request for data connectivity to the first wireless network is reattempted the at least one time without success; and
  - selecting the second wireless network available for communications with the mobile station without reattempting the request for data connectivity to the first wireless network the at least one time if a reject code associated with the rejection indicates that data services are not allowed in the first network is received from the first wireless network in response to the request for data connectivity.

**2**. The method of claim **1**, wherein the request for data connectivity comprises an attach request.

**3**. The method of claim **1**, wherein the request for data connectivity comprises a General Packet Radio Service (GPRS) attach request.

**4**. The method of claim **1**, wherein the reject code indicating that data services are not allowed in the first wireless network corresponds to a permanent problem or fault that exists with the first wireless network.

**5**. The method of claim **1**, wherein the act of reattempting the request for data connectivity to the first wireless network comprises reattempting the request up to a predetermined number of times.

**6**. The method of claim **1**, wherein the act of reattempting is performed by the mobile station without user intervention.

**7**. The method of claim **1**, wherein the request for data connectivity comprises a Routing Area Update (RAU) request.

**8**. The method of claim **1**, wherein the reject code indicative that data services are not allowed in the first wireless network has a value of 14.

**9**. The method of claim **1**, wherein the act of selecting the second wireless network for communications is performed only if the second wireless network is not on an Operator Controlled Public Land Mobile Network (O-PLMN) list or a User Controlled PLMN (U-PLMN) list of the mobile station.

**10**. The method of claim **1**, further comprising identifying one or more wireless networks available in a coverage region of the mobile station, wherein the first wireless network is selected from the one or more wireless networks identified.

**11**. The method of claim **1**, wherein the act of selecting the second wireless network is performed as part of an automatic network selection procedure.

**12**. A mobile station, comprising:
- one or more processors;
- memory coupled to the one or more processors;
- a wireless transceiver coupled to the one or more processors;

the one or more processors being operative to:
select a first wireless network available for communications with the mobile station;
cause a request for data connectivity to be transmitted to the first wireless network selected;
if a rejection is received from the first wireless network in response to the request for data connectivity:
reattempt the request for data connectivity to the first wireless network at least one time;
select a second wireless network available for communications with the mobile station after the request for data connectivity to the first wireless network is reattempted the at least one time without success; and
select the second wireless network available for communications with the mobile station without reattempting the request for data connectivity to the first wireless network the at least one time if a reject code associated with the rejection indicates that data services are not allowed in the first network is received from the first wireless network in response to the request for data connectivity.

**13**. The mobile station of claim **12**, wherein the request for data connectivity comprises an attach request.

**14**. The mobile station of claim **12**, wherein the request for data connectivity comprises a General Packet Radio Service (GPRS) attach request.

**15**. The mobile station of claim **12**, wherein the reject code indicating that data services are not allowed in the first wireless network corresponds to a permanent problem or fault that exists with the first wireless network.

**16**. The mobile station of claim **12**, wherein the one or more processors are further operative to reattempt the request for data connectivity to the first wireless network by reattempting the request up to a predetermined number of times.

**17**. The mobile station of claim **12**, wherein the one or more processors are further operative to reattempt the request for data connectivity without user intervention.

**18**. The mobile station of claim **12**, wherein the request for data connectivity comprises a Routing Area Update (RAU) request.

**19**. The mobile station of claim **12**, wherein the reject code indicative that data services are not allowed in the first wireless network has a value of 14.

**20**. The mobile station of claim **12**, wherein the one or more processors are further operative to select the second wireless network for communications only if the second wireless network is not on an Operator Controlled Public Land Mobile Network (O-PLMN) list or a User Controlled PLMN (U-PLMN) list of the mobile station.

**21**. The mobile station of claim **12**, wherein the one or more processors are further operative to identify one or more wireless networks available in a coverage region of the mobile station, the first wireless network being selected from the one or more wireless networks identified.

**22**. The mobile station of claim **12**, wherein the one or more processors are further operative to select the second wireless network as part of an automatic network selection procedure.

**23**. A communication system, comprising:
a first wireless communication network;
a second wireless communication network;
a mobile station operative to select one of the first wireless communication network and the second wireless communication network for communications;
the mobile station being operative to:
select a first wireless network available for communications with the mobile station;
cause a request for data connectivity to be transmitted to the first wireless network selected;
if a rejection is received from the first wireless network in response to the request for data connectivity:
reattempt the request for data connectivity to the first wireless network at least one time
select a second wireless network available for communications with the mobile station after the request for data connectivity to the first wireless network is reattempted the at least one time without success; and
select the second wireless network available for communications with the mobile station without reattempting the request for data connectivity to the first wireless network the at least one time if a reject code associated with the rejection indicates that data services are not allowed in the first network is received from the first wireless network in response to the request for data connectivity.

**24**. The communication system of claim **23**, wherein the request for data connectivity comprises an attach request.

**25**. The communication system of claim **23**, wherein the request for data connectivity comprises a General Packet Radio Service (GPRS) attach request.

**26**. The communication system of claim **23**, wherein the reject code indicating that data services are not allowed in the first wireless network corresponds to a permanent problem or fault that exists with the first wireless network.

**27**. The communication system of claim **23**, wherein the mobile station is further operative to reattempt the request for data connectivity to the first wireless network by reattempting the request up to a predetermined number of times.

**28**. The communication system of claim **23**, wherein the mobile station is further operative to reattempt the request for data connectivity without user intervention.

**29**. The communication system of claim **23**, wherein the request for data connectivity comprises a Routing Area Update (RAU) request.

**30**. The communication system of claim **23**, wherein the reject code indicative that data services are not allowed in the first wireless network has a value of 14.

**31**. The communication system of claim **23**, wherein the mobile station is further operative to select the second wireless network for communications only if the second wireless network is not on an Operator Controlled Public Land Mobile Network (O-PLMN) list or a User Controlled PLMN (U-PLMN) list of the mobile station.

**32**. The communication system of claim **23**, wherein the mobile station is further operative to identify one or more wireless networks available in a coverage region of the mobile station, the first wireless network being selected from the one or more wireless networks identified.

**33**. The communication system of claim **23**, wherein the mobile station is further operative to select the second wireless network as part of an automatic network selection procedure.

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